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THE QUARTERLY REVIEW of BIOLOGY

OXYGEN UPTAKE AS RELATED TO BODY SIZE IN ORGANISMS

BY ERIK ZEUTHEN

Laboratory of Zoophysiology, University of Copenhagen

1. INTRODUCTION

THERE is a huge literature demonstrating that heat production per unit weight in relatively mature animals of different species, as well as the same species, declines with increasing size. For recent comprehensive reviews, see Brody (1945, chap. 13), Kleiber (1947), Zeuthen (1947), and Hemmingsen (1950). The present paper (see also Hemmingsen) presents an extension of this concept to include organisms from bacteria to large mammals.

Long ago Cope (1885, 1896) showed that there is a persistent and widespread tendency for body size in vertebrate as well as invertebrate animals to increase during their phylogeny. This has become known as the "law of phyletic increase in size" or "Cope's law" (for literature see Newell, 1949). Surveying the whole animal kingdom, the same general tendency makes itself apparent. Protozoa are smaller than invertebrates, and most invertebrates are smaller than the vertebrates. Most invertebrates probably weigh less than a few milligrams, but among the vertebrates the smallest fish, *Schindleria praematurus*, weighs only 2 mg. (Bruun, 1940), and the smallest mammal, the longtailed shrew *Sorex cinereus*, weighs 3.5 g. (Morrison, 1948). This means that when plotting metabolism against body size for representatives of organisms from bacteria to mammals we obtain an approximate survey of the phylogenetic evolution of the respiratory metabolism with body size. This is surveyed in section II of the present paper. In section III metabolic data are plotted against ontogenetic size increase in those few organisms for which such data are available. The comparison of sections II and III will reveal a clear indication of the ontogenetic recapitulation of the phylogenetic evolution of metabolism with size.

The words *respiration*, *metabolism*, and *oxygen uptake* will all be taken to mean "oxygen uptake per organism per hour." The terms *respiratory rate*, *metabolic rate*, and *rate of oxygen uptake* will all be defined as "oxygen uptake per hour per unit of body size." Body sizes are measured either by fresh weight or by Kjeldahl nitrogen determinations. A comparison of measurements which refer to nitrogen with those which refer to fresh weight is possible if we make the sweeping generalization that organisms contain 2.5 per cent of nitrogen. This generalization forms the basis on which the graphs in this paper have been drawn. The word "growth" will be used in its widest sense, as describing phylogenetic as well as ontogenetic increase in size and in metabolism.

The concept of "standard" or "basal" metabolism is useful when it is a question of getting reproducible respiration measurements on one species or on related species. As more and more distantly related organisms are compared, how-

ever, it becomes increasingly difficult, and eventually impossible, to define conditions which are "standard" for all. The only attempt which was made by Zeuthen (1947) was that of using a standard temperature (16°C.) in all experiments. However, it was ascertained in experiments on single individuals of microscopic animals that the metabolism fluctuated comparatively little (<2:1) with transition from different states of activity to a condition of rest. This fortunate circumstance makes it possible to compate data for microscopic animals in "natural activity" with data for larger animals (reptiles; mammals) which have usually been studied while more or less resting.

In his previous paper, Zeuthen (1947) plotted his and other investigators' results as metabolic rates against the logarithm of the body weight. In this way, the metabolism per gram of tissue in different animals could be read directly from the graphs.

In this paper, the total metabolism is related to body size (weight, or body N) using the exponential equation

$$Y = a \cdot X^b \qquad (1)$$

[The equation is here given with the symbols used by Brody (1945). Different authors (among them Zeuthen, 1947) have used different symbols.] This formula implies that for a constant value of b the logarithmic, or percentage, change in Y (metabolism) varies directly with the logarithmic, or percentage, change in X (body size). The exponent b is the ratio of the percentage change in Y to the corresponding change in X. The so-called "surface law," formulated over a century ago, in 1837, by Sarrus and Rameaux, states that the value of b in the above equation is $2/3$ or 0.67. It will be shown that actually b can assume very different values, ranging from 1.0 to negative numbers. It should be stated that in using this exponential equation and therefore drawing straight lines on double logarithmic paper, the author follows common practice. The straight lines should not be understood as attempts to advance biological interpretations on this basis. One cannot be sure, for instance, that the "three-phasic" curve demonstrated in several graphs of the present paper is not actually a very long extended S-shaped curve.

The total range of organisms considered in this paper is from bacteria (weighing 10^{-9} mg.) to large mammals (weighing 1 ton or more). So the total size variation is about 10^{18}. The total variation in metabolism is only about 10^{15}. Looking at the graphs, one will observe that, knowing only the size of an organism, one can fix its metabolism to the two nearest powers of ten, or better. These facts immediately indicate that the influence of body size on metabolism is beyond dispute. The unavoidable scattering of the data is due partly to uncontrollable factors that have little or no relation to size, such as different states of growth, motility, digestive activity or different temperatures of the experiments. Offhand, one would think it possible to correct at least for temperature differences. The bacteria were studied at 37°C., and the protozoa at 25–28°C. These temperatures are significantly higher than the temperature (16°C.) at which the marine organisms were studied by Zeuthen. Other poikilothermic data are from temperatures varying between 13°C. and 25°C. Homeothermic data are valid for normal body temperature, which is close to 37°C. It is generally accepted that the metabolic rate of organisms usually more than doubles when the body temperature is raised 10°C. However, in the course of time, while the organism is still at the high temperature, regulations may set in which again tend to diminish the metabolism. We are totally ignorant of the degree to which the metabolism of all organisms studied may be adapted to the temperature of rearing. For this reason, we can make no reasonable guesses concerning what value of Q_{10} should be employed for temperature correction in any particular case. It has been considered best, therefore, not to apply any temperature corrections at all, although this is against common practice. Fortunately, in view of the tremendous variation in size, this point is not crucial, and actually, in a few cases to be mentioned, the data clearly suggested a temperature correction, which was then applied.

II. INTERSPECIFIC COMPARISONS

(Increase in metabolism with phylogenetic increase in size of organisms)

Unicellular organisms

It is common knowledge that aerobic bacteria consume oxygen at very high rates. Most authors, however, have calculated oxygen consumption per cell rather than per unit volume. Rough approximations can be arrived at by making reasonable guesses as to the likely cell volume of the

organisms studied by others (cf. Rahn, 1940). Huntington and Winslow (1937) made simultaneous measurements of oxygen uptake (at 37°C.) and cell volume in two species of *Salmonella* and in *Escherichia coli*. In Fig. 1 (extreme left), their data are plotted as log O_2 uptake versus log weight while the nitrogen per cell showed very significant variations. As will be seen from Fig. 1, the results of the two groups of investigators do not agree too well.

Further data included in Fig. 1 are those of Lwoff on three flagellates grown in pure culture,

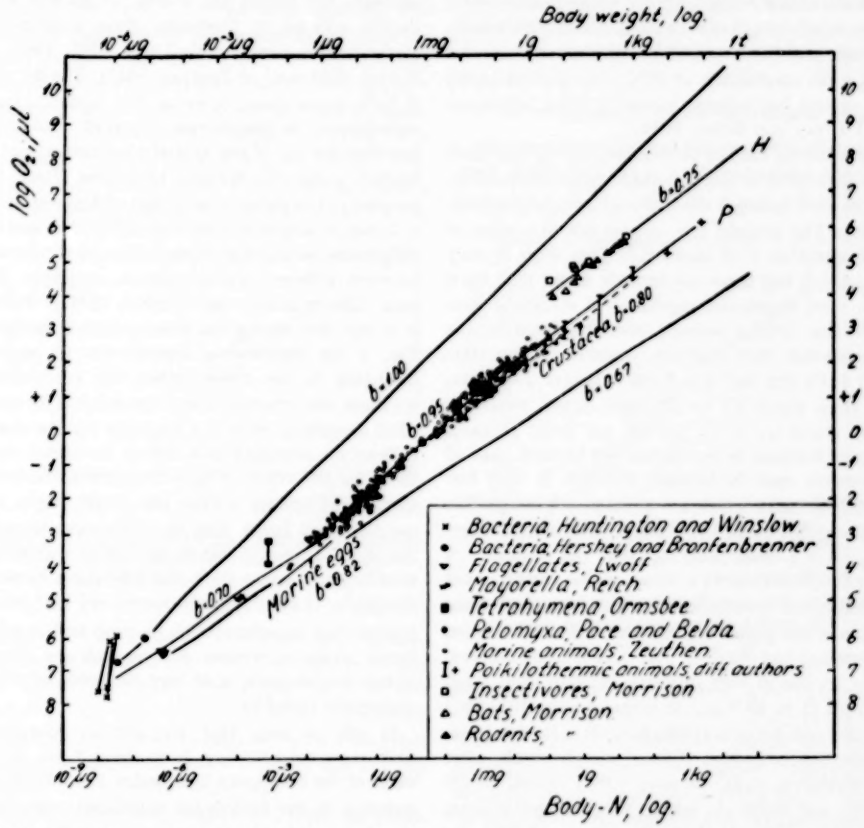

FIG. 1. INTERSPECIFIC COMPARISON OF METABOLISM (O_2-UPTAKE) AND BODY SIZE (FRESH WEIGHT, OR BODY N) IN ORGANISMS RANGING FROM BACTERIA TO LARGE POIKILOTHERMIC (P) AND HOMEOTHERMIC (H) ANIMALS

The marine eggs (25°C.) are from Smith and Kleiber (1950). The crustacea were studied at 15°C. by Weymouth et al. (1944).

of organisms (upper abscissa). The weight is calculated from the volumes on the assumption that the specific gravity of the cells is 1.0. In the figure the lowest and the highest values found for each organism are connected by a line. Hershey and Bronfenbrenner (1937), working on *E. coli*, measured oxygen uptake (at 37°C.) and nitrogen content per cell and found the oxygen consumption per unit of nitrogen to be essentially constant, namely, *Strigomonas oncopelti*, *S. fasciculata*, and *Leptomonas* sp., all studied at 28°C. The results have been recalculated from Table 4 of Jahn (1941) and they are plotted as log O_2 against log N. The dry matter was assumed to contain 10 per cent N, as is the case in an amoeba (Reich, 1948) and in the ciliate *Tetrahymena geleii* (Ormsbee, 1942). The amoeba *Mayorella palistinensis* was grown in pure culture by Reich (1948), and its

oxygen uptake was measured at 27° C. From Reich's data it is possible to calculate the oxygen consumed as well as the nitrogen contained per cell. Ormsbee's (1942) results (27°C.) for the ciliate *Tetrahymena geleii* grown in pure culture are plotted as log O_2 against log N. The highest and the lowest oxygen uptake found in Ormsbee's own experiments has been used. Finally, the results of Pace and Belda, working with the large amoeba *Pelomyxa carolinensis* at 25°C., are plotted as log O_2 against log volume, specific gravity but equal to 1 (Pace and Belda, 1944).

In drawing the line (lowest line) in Fig. 1, regard has been paid to the fact that temperature differences exist between the different groups of experiments. The straight line corresponds to a value of b in equation 1 of about 0.7. This slope is very ill-defined, but there can be little doubt that there is a very significant regression of metabolic rate with size. This is perhaps best illustrated by the information that bacteria consume about 100–500 l. O_2 per kg. per hour. whereas *Pelomyxa*, which is about 10^7 to 10^8 times larger, consumes only about 0.2 l. O_2 per kg. per hour. A much further increase in protozoan size beyond that of *Pelomyxa* may be thought to result in very low metabolic rates which are perhaps not compatible with further evolution along protozoan lines. Anyway, it is a remarkable fact that the evolution of small metazoa marks a break in the further rapid reduction of metabolic rate with increasing size.

Since this paper was finished, Scholander (pers. commun.) has obtained new data relating metabolism to size in four protozoa ranging from small ciliates (2×10^{-2} μg.) to large amoeba (10^{-2} mg.) Holter and Zeuthen (1948) have data for five large, individual amoebae (*Chaos chaos*) which after recalculation run: volumes 0.098, 0.054, 0.078, 0.083, and 0.050 μl., respectively; oxygen uptake, at 21°C, 0.023, 0.011, 0.013, 0.014, and 0.22 μl./hr., respectively. Scholander's data fill the gap smoothly between the observations for *Tetrahymena* and those for *Pelomyxa*, both included in Fig. 1, and together with the data of Holter and Zeuthen they also slightly extend the graph in this region. For the size range considered, the value of b appears to be even lower than indicated in Fig. 1, that is, about 0.55 rather than 0.7.

Metazoa containing less than 1 mg. N

In Fig. 1, the author's measurements (open circles) on marine metazoa at 16°C. are plotted as log O_2 against log body N. The body sizes of the organisms studied range from those corresponding to about 10^{-2} μg. N to about 5×10^2 mg. N, i.e., a range about 10^7 to 10^8 times. The measurements on animals larger than those corresponding to 0.1 mg. were mostly obtained by the Winkler method; the values for smaller organisms were mostly secured in Cartesian diver experiments (technique of Linderstrøm-Lang, 1937, 1943; of Holter, 1943; and of Zeuthen, 1943). The 0.1 mg. N limit is not sharp, however. For instance, mass experiments on plancktonic copepods containing less than 0.1 μg. N per animal were carried out in bottles, using the Winkler procedure. Since the purpose of this publication is that of demonstrating unifying principles in organisms rather than specific differences, no attempt is made here to distinguish between different species, genera, or phyla. For such differentiation, see Zeuthen (1947). Suffice it to say that among the observations included in Fig. 1 are represented experiments on species belonging to the coelenterates, the vermes, the molluscs, the crustacea, and the fishes. For equal sized organisms there is a tendency for the observations on crustacea and fish to lie higher than those for the other animals mentioned. However, species differences within the single phyla are usually much larger than the differences between the phyla. It should also be mentioned that points usually more larger than the differences between the phyla. It should also be mentioned that points representing experiments on growing and on adult forms scatter at random. Size as such and oxygen uptake are the only, or at least the predominating, systematic variables.

It will be seen that for animals containing little more than 10^{-2} μg. N to about 1 mg. N the value of the constant b in equation 1 is 0.95. Thus, contrary to our finding for unicellular organisms, size increase in the range of the small metazoa can occur without any serious reduction in the metabolic rate. The metabolic rate of animals containing 1 mg. N is about 50 per cent (or a little less than 50 per cent), of that of the smallest metazoa considered.

The results obtained on microscopic and small marine animals containing less than 1 mg. N have been substantiated through recent experiments by Overgaard-Nielsen (1949), working in this laboratory on soil nematodes (16°C.). From his Table 20 the data are plotted in Fig. 2. The biggest of the animals is a marine species, the others are soil

animals. The slope of the curve corresponds to a value of b of 0.9. This is about the same high value as that found for equally small marine animals.

Poikilothermic metazoa containing more than 1 mg. N

As soon as we consider animals containing more than about 1 mg. N, it becomes apparent that the metabolism grows with a smaller power of the body weight than that found for the metazoa containing less than about 1 mg. N. The author's results (Fig. 1) show this fact, and are in agreement with the results of Hemmingsen (1950). For crustacea weighing from 23 mg. to 520 g., Weymouth et al. (1944) found a direct linear relation between log O_2 and log weight. The value of b was

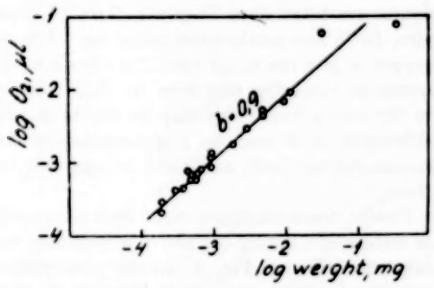

FIG. 2. INTERSPECIFIC COMPARISON OF METABOLISM AND BODY WEIGHT IN SOIL NEMATODES
(Data from Overgaard-Nielsen, 1949)

about 0.8. The curve of Weymouth and collaborators is introduced into Fig. 1, the abscissa being on top of the figure. The displacement of this curve to the right in the figure, in comparison with Zeuthen's data, is explained by assuming that for the crustacea our general estimate that animals contain 2.5 per cent N is too high.

Zeuthen (1947) compiled data from the literature dealing with the larger poikilothermic animals, including crustacea, fish, amphibia, and reptilia. The range of these data is recalculated from his Fig. 46. In Fig. 1 of this paper they are represented by a straight line and range indications. It will be seen that this line, representing the larger poikilothermic animals in general, does not deviate significantly from the line representing the crustacea alone. The value of b comes out to about 0.76, as compared to 0.80 in the case of the crustacea. Thus, for poikilothermic animals in general, growth beyond sizes corresponding to 1 mg. N does not take place without a serious reduction of the metabolic rate occurring at the same time. Animals containing 1 mg. N have an intensity of metabolism which is on the average 20 times as high as that of the 10^5 times larger animals containing 100 mg. N. This is in sharp contrast to the slight (50 per cent) reduction in the metabolic rate that takes place as a result of the 10^5 times increase in body size in the range of the small metazoa containing less than about 1 mg. N.

Experiments on marine crustacea

The smallest crustacean studied by Weymouth et al. weighed 23 mg., i.e., it contained a little less than 1 mg. N. Accordingly, it was not to be ex-

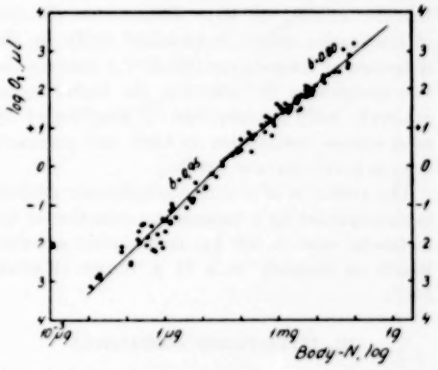

FIG. 3. INTERSPECIFIC COMPARISON OF METABOLISM AND BODY N IN MARINE CRUSTACEA
(Data from Zeuthen, 1947)

pected that these authors would have found values of b in the neighborhood of 1.0. Such values pertain to animals significantly smaller than those studied by the Californian workers. The present author studied crustaceans containing 10^{-2} µg. up to 100 mg. N, corresponding to weights between about 0.4 µg. and 4 g. The results are plotted in Fig. 3. For animals containing less than about 0.1 mg. N, the value of b in equation 1 appears to be around 0.95, while for animals larger than this b is smaller, namely, 0.80. Thus, within a single group of metazoan animals we get a confirmation of the general rule established for poikilothermic animals: for animals below a certain size the regression of metabolic rate with size is very slight, whereas for larger animals this regression is much greater. As in all other such cases represented in this paper, the transition from one value of b to another is not at all sharp.

Homeothermic animals

For mammals the basal metabolism is known to vary with the 0.75 power of the body weight. Kleiber's curve (H) (1947) is introduced into the present Fig. 1. It has practically the same slope as the curve for poikilothermic animals larger than 1 mg. (Hemmingsen, 1950, Fig. 1), although on a higher level. In the range of the smaller mammals, the data of Morrison (1948) for bats, rodents, and insectivores have been used in Fig. 1.

Mammals are generally heavier than the invertebrates for which the same regression of metabolic rate with size holds. Furthermore, for equal body size, vertebrates use about twenty times as much oxygen as invertebrates. As suggested by Benedict (1938), this large difference in the rate of combustion cannot be explained solely by the difference of temperature (10–20°C.) between the two groups. On the contrary, the higher homeothermic body temperature is conditioned by more intense combustion in birds and mammals than in poikilothermic reptiles.

The evolution of size in homeothermic animals is accompanied by a tremendous reduction in the metabolic rate. A 600 kg. cow respires one-thirteenth as intensely as a 21 g. mouse (Kleiber, 1947).

III. INTRASPECIFIC COMPARISONS

(Increase in metabolism with ontogenetic increase of body size in organisms)

Ontogenetic recapitulation of the phylogenetic evolution of the metabolic rate

In a few cases, all of which pertain to marine or to brine animals, we have sufficient data to trace the metabolism as a function of the body size throughout the ontogeny, from egg or young larva to adult animal. Such casea are *Mytilus edulis* (Zeuthen's data, 1947, at 16°C.), *Artemia salina*, and *Asterias rubens*. For *Asterias*, the author's measurements on larvae and just metamorphosed young starfishes (at 16°C.) have been supplemented by the extensive data of Helga Meyer (1935) for larger animals (temperature not given). Helga Meyer's animals were assumed to contain 1 per cent N, as found for *Asterias* from Danish waters. Working in this laboratory, Eliassen (unpub.) grew *Artemia salina* from egg to sexually mature individuals, using yeast as sole food. He measured oxygen uptake (at 16°C.) with a Winkler method and referred his results to the nitrogen contained per animal. For all the three mentioned animals, log O_2 is plotted against log N in Fig. 4.

Data dealing with metabolism and weight in developing frogs have been compiled from the literature. Data for adult frogs were taken from Terroine and Delpech (1931). Their results (at 20°C.) are corrected to 15.4°C. by multiplication by the factor 2/3. This is necessary since the experiments of Groebbels (1925) on just metamorphosed frogs, which are also introduced into Fig. 4, were performed at the latter temperature. Groebbels performed experiments also on frog tadpoles. In Fig. 4, however, the less variable results of Gayda (1921) for heat production in tadpoles of *Bufo* have been used for comparison with the frog. The figures are taken from Shapiro's Table 71 (Shapiro, 1948) and recalculated, assuming 1 liter of oxygen to give rise to 4.7 Cal. There is a jump in metabolic rate as we pass from the *Bufo* tadpoles to the young frogs. This may be due to generic differences or it may be a consequence of the metamorphosis itself, as Groebbels suggested for *Rana*.

Finally, scattered information about the growth of metabolism during the life of a mammal, the rat, was collected. Fig. 4 includes observations on embryos which were studied during cleavage stages (Boell and Nicholas, 1939, recalculated by Zeuthen, 1947, p. 142), with further data for an embryo weighing 77 mg. studied by Kleiber, Cole, and Smith (1943). For animals studied after birth, data were taken from Brody's book (1945, Table 14, 1a, p. 451, observations marked by an asterisk not included; also Brody's differentiation between males and females is not taken into account). The two first groups of observations for mammals are represented in Fig. 4 by single points, and the last group by a swarm of points.

Fig. 4 shows that the phylogenetic evolution of the metabolic rate which was demonstrated in Fig. 1 appears to recapitulate itself during ontogenesis in the animals studied. Admittedly, this conclusion is very crude, especially as regards the mammal. It seems possible, though, that this animal behaves no differently with respect to the ontogenetic evolution of the metabolic rate than do the other animals. Thus, for all the animals studied, there would seem to be a period of (approximately) directly proportional growth of the metabolism and the whole body. For the small species *Artemia*, this growth period is short. For

the larger species and especially the rat, this period is long.

METABOLISM AND GROWTH LIMITATION

In *Asterias*, and perhaps also in *Artemia*, the metabolism during the final phase of growth varies with a fractional power of the body weight which is distinctly lower than any found in interspecific comparisons of cold-blooded animals (compare Figs. 1, 2, 3). Thus, the final growth of metabolism with body size not only repeats phylogenesis, but

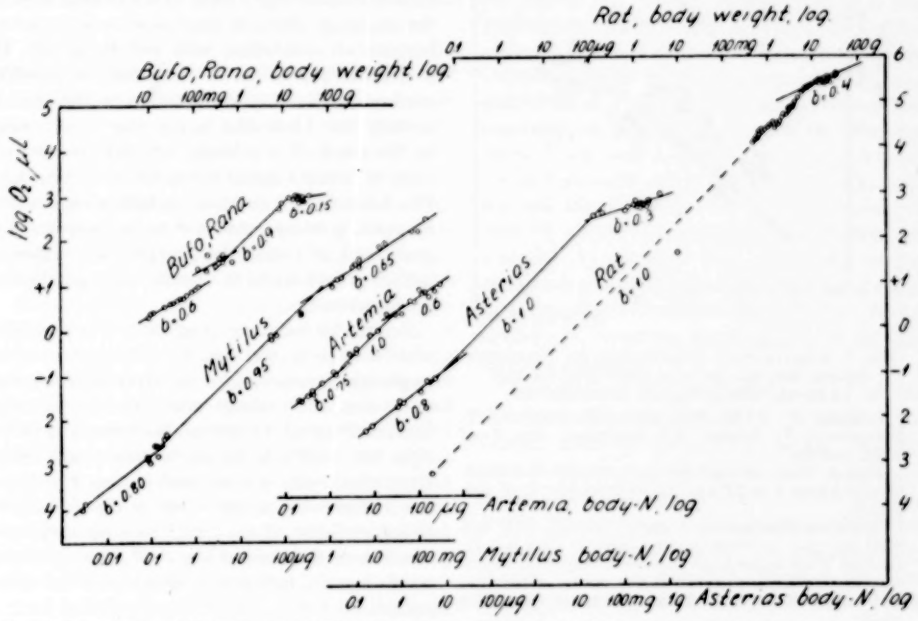

FIG. 4. INTRASPECIFIC COMPARISON OF METABOLISM AND BODY SIZE IN DIFFERENT ANIMALS DEVELOPING FROM EGGS OR LARVAE INTO MATURE STAGES
All rat body weights should be multiplied by 10.

even exaggerates it. Brody (1945, Fig. 13, 9, p. 372 and chapter 14) has plotted curves which indicate that, in a general way, this principle is adopted by the mammals, so probably it is generally valid. Kleiber, in his recent review (1947), has maintained that the slope of curves dealing with metabolism versus size in single mammalian species is usually ill defined. For this reason, Kleiber considered that values of the exponent b pertaining to single species cannot be considered to be statistically different from the value found for mammals as a whole. It must be remembered, though, that if a tendency repeatedly makes itself apparent in experiments by different authors who are using different animal species, it becomes increasingly likely that this tendency depicts a true biological phenomenon.

In a few cases authors have studied poikilothermic animals over a comparatively narrow range near the maximum size of the species. In Fig. 5, the data of Edwards (1946) on males and females of the house-fly *Musca domestica* (temperature not given) and on the beetle *Melanotus communis* (17°C.) are recalculated. Edwards' experiments on *Melanotus* gave comparable results at temperatures from 12° to 40°C. Another animal studied by Edwards was the beach flea, *Talorchestia megalopthalma* (17°C.). Edwards and Irving earlier (1943b) studied summer and winter forms of *Talorchestia* at 12–13°C. and at 22–23°C. They found that the metabolism varied with size in different ways, depending on temperature and on the physiological state of the animal. In plotting their data, however, it appears that in all cases the metabolism varied with a very low power of the body size, the highest value of b in equation 1 (found in summer animals at 22–23°C.) not ex-

ceeding 0.5. While the data of Edwards and Irving on *Talorchestia* are not included in Fig. 5, use has been made of their results (read from their graph on p. 178, 1943a) on the crab *Emerita talpoida* (16°C.). All experiments of Edwards and of Edwards and Irving were performed with the Scholander respirometer and should therefore be comparable. In all cases the measurements represent basal metabolism, because only measurements obtained after the metabolism had reached a constant

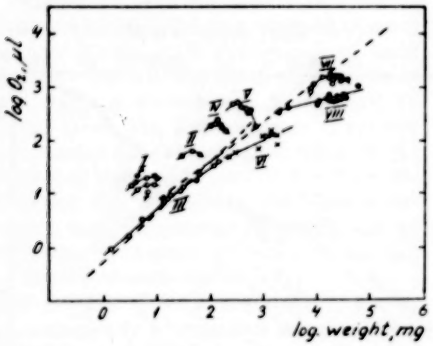

FIG. 5. INTRASPECIFIC COMPARISONS OF DIFFERENT ANIMAL SPECIES STUDIED OVER SIZE RANGES NEAR THE FINAL SIZE OF EACH SPECIES

I, *Musca* ♂, ♀. II, *Melanotus*. III, *Tenebrio*. IV. *Talorchestia*. V, *Emerita*. VI, *Lumbricus*. VII, Frog, VIII, *Asterias*.

Broken lines, interspecific comparisons of animals weighing from 1 to 10^5 mg. (taken from Fig. 1 of this paper).

While the observations in curves III, VI, VII, and VIII are from published tables, those in Curves I, II, IV, and V are either from published graphs or represnt single points on smooth curves drawn by the present author through scattered points in published graphs.

low level were accepted. Also on *Emerita* and *Talorchestia* the important check was made of ascertaining that the percentage of trypsin-digestible material (which should not include, e.g., collagen) was constant throughout the period of growth studied. As will be seen from Fig. 5, the general result of those experiments was that the metabolism of the animals increases very little with size. In some animals, and especially so in *Emerita*, there is even a decline of metabolism at the same time as there is continued growth of the body. The smaller individuals of *Emerita* simply consume more oxygen than the bigger ones.

Other experiments represented in Fig. 5 are those of Teissier (1931, Table 19) on meal worm larvae (*Tenebrio*) studied at 20.4°C. Furthermore, the results of Meyer on *Asterias* (at 20°C. ?) of Terroine and Delpech on the frog (20°C.), and of Davis and Slater (1928) on the earthworm (25°) are included. For comparison with all the groups of experiments mentioned, the main curve from Fig. 1 is redrawn in Fig. 5. The general conclusion to be drawn from Fig. 5 is that, apparently, as soon as a species approaches its maximum size, its log O_2-log weight curve tends to deviate from the main curve. All experiments used for the construction of Fig. 5 have as a common feature the extremely slight, in some cases even negative, increase of metabolism with growth in size. It is difficult not to see in these facts a possible mechanism resulting in limitation of the species in body size. Limitation in size may in each case be the result of a primary, complete or partial, block of further increase in respiratory metabolism. The formation of enzymes, including respiratory enzymes, is today considered to be controlled by genes, and, of course, the limitation of organisms in their growth is also to a major extent genetically predetermined.

Before this section is concluded, it is probably wise to make it clear that not all experiments on single species reported in the literature show the steep drop in metabolic rate with size near the maximum size of the species. However, it is probably not justifiable to try to treat statistically the pooled results of other workers, and it is therefore not possible to say anything about the statistical validity of the tentative conclusions arrived at on the basis of Fig. 5. If others find the conclusions suggestive they have served their purpose.

IV. DISCUSSION

(1) No values of the exponent b in the equation have been found which are higher than 1.0. Exceptions to this general rule are found in Chapter 14 of the book by Brody (1945). Such exceptions, however, are valid only for very narrow size ranges, and can easily result from changes in physiological factors other than size as such. Consequently, we may state that the sum of enzymes, metabolites, and perhaps inhibitors which govern metabolic activity grows less than the totality of the protoplasm. This sum may grow almost as much as the totality (as in marine metazoa containing 10^{-2} g. to 1 mg. N), it may grow much less than the whole body (as in many instances to be found in the

graphs), or it may even decline at the same time as the body grows larger (as in *Emerita* and others, Fig. 5). That b never exceeds 1.0 is believed by some to be a consequence of the organization of life itself. Prigogine and Wiame (1946) indicated that for thermodynamic reasons the metabolic rate can never increase, but only decrease, with evolution of body size in organisms. The formulation of Prigogine and Wiame is qualitative and accordingly does not tell us anything concerning the extent to which metabolism drops off with size. Also it gives us no information about the mechanisms that are at work.

(2) From the present paper there emerges the important fact that the ratio between the extent of increase of the metabolism and the growth of the whole organism is subject to modification in evolution by the organisms. Evolution of size has always been resisted by the fact that, for reasons residing in the living matter, the metabolism always grows less than the body. Organisms were always in danger of outgrowing their energy-supplying mechanisms. The evolution of size—ontogenetically and phylogenetically—is the history of success and defeat in finding means of developing size without at the same time developing excessively low metabolic rates. Among the unicellular organisms metabolism grew at about the 2/3 power of the body weight. This is quite close to a surface relationship, so that—although I consider that the surface concept has dominated our thinking in this field far too much—I must admit that no one can exclude the possibility that cellular surfaces in some way have been limiting for evolution in these organisms. Simple calculations indicate, however, that neither the exchange of heat nor of small molecules like O_2 and CO_2 can have been limiting. Whatever the limiting factors have been, the result was very low metabolic rates in the larger protozoa.

The metazoa were the evolutionary answer to this situation. Where rate of metabolism is concerned, they have their roots among the protozoa (cf. Fig. 1), but they managed to keep up a long growth phase during which they suffered only a very slight decrease in metabolic rate. Whereas in unicellular organisms cell surface equals body surface, this is not so in metazoans. Metazoa grow by adding new cells rather than by growing bigger cells, so that total cell surface grows more or less in proportion with the body weight, and not with the body surface. Consequently, in small metazoans metabolism grows rather closely with total cell surface, like it did in the protista.

All animals weighing less than about 1 mg. can be calculated to be sufficiently supplied with oxygen throughout (formula for respiring sphere published by Goddard, 1945). In the range of animals weighing 40 mg. (equal to about 1 mg. N), the nearly proportional growth of metabolism with size shifts to a phase during which the metabolism grows definitely at a lower rate than the whole body.

From this point on, the metabolism calculated per unit of body surface increases less with size than was the case in smaller animals. In view of the scattered nature of the observations, the difference between 1 and 40 mg. is not so impressive that the possibility of a causal connection between the beginning of anaerobiosis in animals weighing about 1 mg. and a reduced rate of growth of metabolism which sets in for animals weighing 40 mg. can be entirely ignored. For the present, it may be sounder, however, without further explanation to recognize that, when body weight exceeds about 40 mg. the growth of metabolism with size switches back to relations which show a similarity to what was found already in the unicellular organisms.

(3) A glance at Fig. 1 will convince most readers that homeothermic animals took over from poikilothermic ancestors—only on a higher level—the general slope of the curve relating the logarithms of the metabolism to the logarithms of the body weight. The real evolutionary problem is how they managed to establish so high a metabolic level, without which homeothermic life would not have been possible. Fig. 4 shows at least one way in which species or groups of animals could have modified the intensity of metabolism which they acquired according to their size. The curves of Fig. 4, as drawn, each consist of three segments. The relative lengths of these pieces are subject to variation from one organism to another. The middle portion of the curve is short in the small species *Artemia*, but is long in the larger species *Mytilus*, *Asterias*, and probably the rat. The likely answer to the above evolutionary problem is that early homeothermic animals acquired the trick of extending the period of nearly proportional growth of metabolism and size (equal to middle segment of the curves of Fig. 4), more than did their poikilothermic ancestors. The result was to produce large animals with metabolic rates

high enough to make elevated and regulated body temperatures possible.

(4) Hemmingsen (1950) has emphasized that very large animals would never have developed if the metabolism in animals above a certain size had not varied closer with the amount of body surface than with the body weight. Surface processes (absorption from the intestine, heat dissipation from the surface) would have become limiting. This is demonstrated by calculations comparing small animals with hypothetical giants having the same high metabolic rate as the small ones. Such considerations readily lead to the assumption that the manner in which the over-all metabolism increases interspecifically with the body weight represents an adaptation to the needs of the organisms. It should be stated, however, that probably such adaptations were major evolutionary accomplishments which mark colossal jumps in animal evolution. The transition from unicellular to multicellular life and from poikilothermic to homeothermic animals are cases in point (see Fig. 1).

Evolution within large poikilothermic and within homeothermic animals took place on the basis of established relationships between body size and metabolism which were already acquired in animals growing beyond certain small sizes, and these relations have been strongly held ever since (cf. Fig. 1). We may agree with Hemmingsen that these relations were quite fortunate; on the other hand, they were hardly the best possible. In small mammals the basal heat production per unit of surface is only one-fourth of that in large homeotherms, the deviations from the "surface law" accounting for this (Benedict, 1938). At the same time, small animals do not have the same opportunities as big ones for insulating themselves, because the maximum thickness of the fur is less and the available temperature gradient in the skin is shorter in small than in big animals. Consequently, small mammals have all kinds of trouble in keeping warm. Had the metabolism in mammals been fully adapted to the needs of the organism we should have expected the metabolism to vary with a power (b) of the body weight smaller than 2/3, and not—as is actually the case—with one larger than this value (3/4). It would have been advantageous—from the point of view of the animals— if such a low value of b had resulted from a higher rate of metabolism in the range of small animals, not from a lower rate in the range of large animals.

All facts considered together are understood if we accept the conclusion previously set forth that the basal metabolism in mammals—as in other animals— is adapted to the needs of the species to a lesser extent than the species are adapted to the metabolism derived according to their body size and the phylogenetic history of their whole group. What caused the value of b in the power equation to change from 0.95 to 0.70 in animals growing beyond certain small sizes we do not know. Ultimately, this must be understood on an evolutionary basis. Perhaps in the future some insight into this problem may be gained by considering conditions of life in animals ranging around the size where the value of b changes.

(5) Over long periods of phylogenetic and ontogenetic growth we observe approximations to directly linear relationships between log O_2 and log weight. Instances are given in this paper and in the paper by Hemmingsen (1950). If straight lines on double logarithmic paper have any simple biological meaning, they indicate that the ratio between the percentage change in metabolism and the percentage change in body weight remains constant. To use Huxley's picture for "relative growth": The part (metabolism) and the totality (body) are like two capitals that grow in the bank at different continuous increments. The value of b in the exponential equation indicates the ratio between the two increments. This ratio is subject to changes which are either reminiscent of revolutions in the phylogenesis of animals or which in the single species mark the end of ontogenetic growth. The genetic implications of these facts ought to be discussed in relation to our present knowledge both as to the genetic structure underlying the growth phenomena and to the genetic basis of the enzyme synthesis.

(6) The depression of metabolic rate with increasing size in organisms is not reflected in a more efficient utilization of energy for growth in the larger, less intensely respiring organisms (Rahn, 1940). Rather, it may be the other way around. The high rate of generation of energy in small organisms can be used not only for sustaining fast growth, and thus for keeping up a population on which other organisms graze, but also this high rate of metabolism is a prerequisite of the growth of small organisms into big ones. In this

case, the price to be paid is the high rate of energy production itself. So small species with an intense metabolism had the choice of remaining small, but fast growing, or of growing big and sluggish. Since in nature small and big organisms exist side by side, both alternatives must have been of survival value. Consequently, the balance among organisms in nature must be established on the basis of the existing very primitive relations between body size and metabolism. To what extent environmental conditions have been responsible for establishing these relations by way of natural selection is hard to decide. The present discussion is written under the impression that once such relations were acquired they were largely non-adaptive.

SUMMARY

Interspecific Comparisons:

1. Plotting the metabolism (O_2-uptake) of species against their respective body sizes (fresh weight, body N) on double logarithmic paper, one observes a continuous, three phase curve.

2. In the range of unicellular organisms (bacteria to the large amoeba *Pelomyxa*) the slope (b) of the curve is 0.7. In the range of small metazoa (eggs and larvae of marine organisms to organisms containing about 1 mg. N), b is 0.95. For poikilothermic animals larger than this and for homeothermic animals, b is about 0.75. However, the curve is on a higher level for the homeothermic than for the poikilothermic animals. The slope of the curve, b, is identical with the exponent in the equation $Y = aX^b$. It indicates the ratio of the percentage (logarithmic) increase in metabolism (Y) to the percentage (logarithmic) increase in body mass (X) in organisms.

Intraspecific Comparisons:

1. Plotting metabolism against body size on double logarithmic paper, and going from egg to adult in different species of animals, one gets three phase curves resembling those described above. Thus, increase of metabolism with size is an example of ontogenetic recapitulation of the phylogenetic evolution in organisms.

2. Cessation of growth in the several species is preceded and perhaps effected by a period during which there is a very slight increase or even a decrease in the over-all basal metabolism, at the same time as there is continued growth of the body.

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FOREST SOIL AS AN ECOLOGICAL COMMUNITY

WITH SPECIAL REFERENCE TO THE FAUNA

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I. INTRODUCTION

SOME organisms which occur in forest soil are primarily concerned with the decomposition of plant litter and its conversion to "humus." Others are of secondary importance in humus formation but they indirectly affect the rate of its formation; these are the predators of fungi, bacteria, and other groups which decompose plant litter. Still others, such as the many insect larvae and pupae which hibernate or aestivate in protected places, simply use the soil as a shelter. A further group live in the soil but feed on living roots of plants. There are others, like the bacteria, which fix atmospheric nitrogen Clearly the processes going on in the soil are many and various, but in this essay-review we are only concerned with that group of organisms which are associated either directly or indirectly with the breakdown of plant litter. It is not unrealistic to consider them together as a group, for they are linked in an ecological "food-web" and can be studied most effectively as a "community" of organisms. It is not at all easy to define the boundaries of this community. In certain cases organisms like the root feeders may play an important part in this community. Their feces and dead bodies contribute to the organic matter in the soil. There are still other animals which do not live in the soil, such as birds, yet which obtain some, or all, of their food from soil organisms. Some of these animals may be important in mixing the plant litter with the mineral matter of the soil (see Jacot, 1940; Hamilton and Cook, 1940). Root feeders belong to the soil fauna, but for the purposes of his paper we are concerned with them only in so far as they may make some contribution to the processes of humus formation. Insects such as caterpillars, which feed in the canopy of the forest, make an indirect contribution by their feces, which drop to the forest floor.

The student of humus formation is faced with the necessity of knowing something about the roles of many different sorts of organisms in soil. Even the botanist, whose primary interest may be in the role of the bacteria and fungi, must know something about organisms which feed on bacteria and fungi or which may make plant litter more readily attacked by these organisms. In other words, he needs to know something about the soil as an ecological community. The lack of such a conception is doubtless responsible to some extent for the scarcity of information on the relative roles of different organisms in plant litter decomposition. This is particularly true of the role of animals; here too there is the additional difficulty of determining the feeding habits of the soil fauna, but these difficulties are being overcome.

When Waksman (1927) first published his book on the microflora and microfauna of the soil, it had already been shown that many species of animals inhabited the soil in very large numbers. But until recently (Bornebusch, 1930; Overgaard, 1949; Kuhnelt, 1950) there had not been any synoptic approach to the study of the organisms of the soil as an ecological community. There are, of course, all sorts of difficulties in providing an over-all picture of what organisms are doing in such an environment. The numbers, both of species and of individuals, are enormous, and the study even of one species is a major undertaking. It cannot be claimed that a great deal is yet known about many species. It could be argued that much more needs to be known about the physiology and ecology of single species before attempts are made to get a synoptic picture. But it is our conviction that the stimulus for further studies of single species in this environment depends to a consider-

able extent upon the appreciation of how such studies can contribute to a total understanding of what animals and other organisms are doing in the soil. It is not our purpose to present a comprehensive review of the soil fauna, for this had already been done by King (1939), Jacot (1940), and Fenton (1947), but to suggest a general scheme of study of forest soil as an ecological community. Although we are primarily concerned with forest soil, some reference will be made to agricultural soils, especially where the studies of particular groups of animals, such as earthworms, have been mostly made in agricultural soils.

II. ECOLOGICAL GROUPING OF ORGANISMS IN SOIL

If we confine our attention to those organisms which are concerned either directly or indirectly with humus formation, it might be possible to work out a series of food chains from which a "food-web" could be constructed for the community. It seems wiser, however, to attempt only broad groupings at this stage, since the number of organisms in soil is tremendous, and very little is known about them; this has been done diagrammatically in Fig. 1. The center square in Fig. 1 represents the plant litter and associated animal remains. It is the material which is converted into humus. A space is reserved in this central square for algae. They are an important constituent of soil in some places. The central square "leaf litter" is surrounded by three groups of organisms, all of which feed directly on litter. They are bacteria (group 1 in Fig. 1), fungi (group 2), and animals which are mainly arthropods and annelids (group 3). These organisms, which are responsible for the decomposition of litter, are referred to collectively as "decomposers." Organisms in each of these three groups are preyed upon by animals, or more rarely by fungi, e.g., the carnivorous Hyphomycetes and the Zoopogaceae (Phycomycetes). These predators are referred to as "predators of bacteria" (group 5), fungal feeders (group 6) and macropredators (group 7). The macropredators are so called because they are large enough to feed upon annelids and arthropods. They are shown in the outer sections of Fig. 1. It is probable that many arthropods and annelids shown in group 3 have their specific predators, and this is suggested by the dotted line on the right of the diagram. If these were known they might be called "primary predators"; the predators of these, "secondary predators"; and so on. On the left of Fig. 1 are the micropredators (group 8). These feed on bacterial feeders (group 5) and algal feeders (group 4).

In Fig. 1 the microfauna (groups 4, 5, and 8) is separated from the rest of the soil fauna since there appear to be no obvious food-chains linking the microfauna with the macrofauna. The two groups of fauna live in different habitats in the soil. The microfauna is characteristically active in the soil water films, whilst the macrofauna occupies air spaces in the soil (see Section IV). This does not mean that the two groups of organisms do not influence one another. For example, Clark (1949) has shown that the succession of microfauna on a decomposing leaf is determined to some extent by the presence or absence of feces of larger organisms such as amphipods, which may have been feeding on the leaf. The major groups of animals which comprise the six categories of the soil fauna are shown in Fig. 1. The list includes all groups which are known to play some part as decomposers or predators. Not all of them occur in all forest soils. Those which are present in the soils of rain forests which we have studied in the Sydney district of New South Wales are marked with an asterisk. This particular fauna contrasts strikingly with the fauna of an entirely different type of litter also found in the Sydney district, but in drier habitats, namely, that of *Casuarina* ("She-Oak") stands. Group 3 in Fig. 1 forms the dominant element in the fauna of rain forest litter, but this group is only sparsely represented in *Casuarina* stands. Group 6, on the other hand, is sparsely represented in the rain forest litter but appears to be the dominant group in *Casuarina* litter. Groups 4, 5, and 8 occur in both types of litter in large numbers. Before considering possible reasons for such differences in the fauna of different plant-litters, it is necessary first to consider the feeding habits and behavior of these six categories of animals.

III. FEEDING HABITS AND BEHAVIOR OF SOIL FAUNA

A. Plant Litter Feeders

It is now well known that only a certain proportion of the animals which feed on plant litter can feed on this substance in its initial condition when it falls to the ground. As soon as the litter has undergone a partial breakdown, others are able to feed on it. In other words, there is a succession of feeding organisms associated with the successive changes in composition of the plant litter as it approaches the complex ligno-protein which Waksman and others refer to as humus proper.

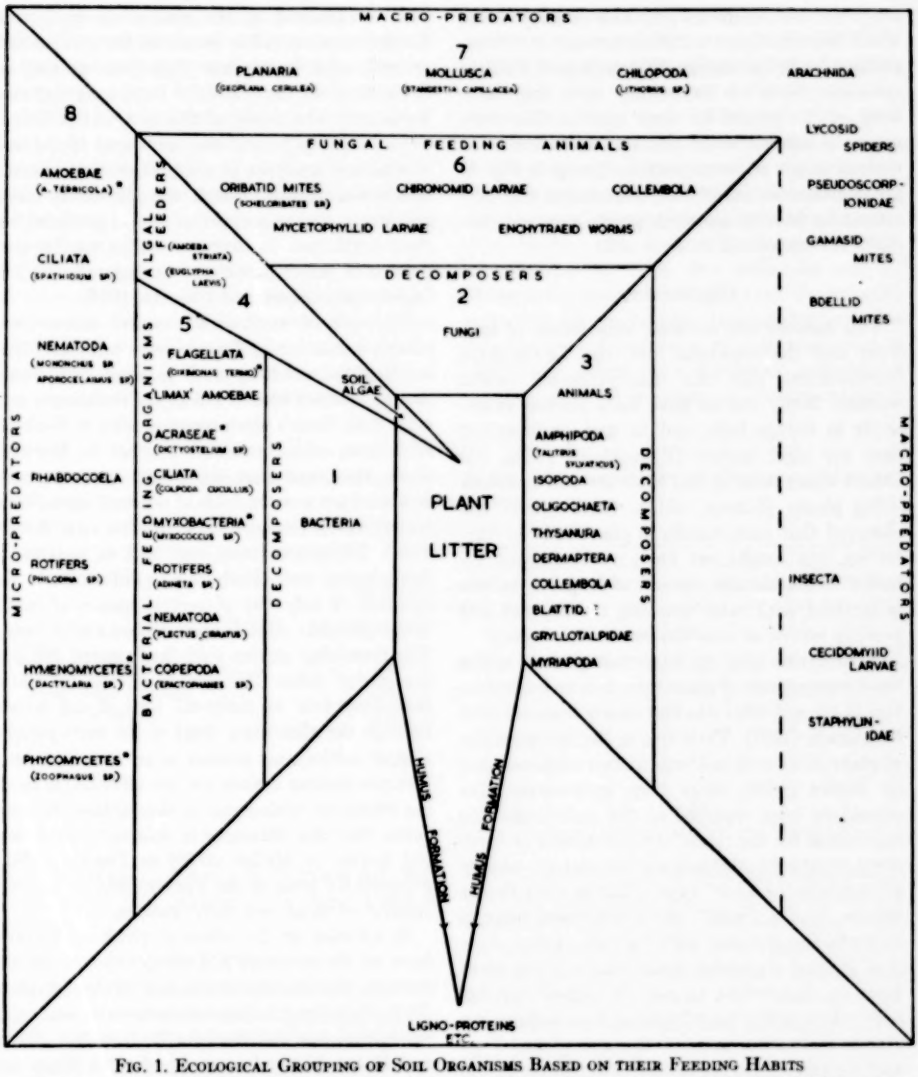

FIG. 1. ECOLOGICAL GROUPING OF SOIL ORGANISMS BASED ON THEIR FEEDING HABITS

All these organisms have been recorded from rain forest soil in the Sydney district of New South Wales except those marked with an asterisk. In some cases examples are given of genera which are common. According to observations made by Lindquist (1941) and Riha (1951), molluscs and oribatid mites could also be included in the list of decomposers (group 3) in European forests.

It is possible that a classification of these organisms may one day be given in terms of the stage in decomposition at which they feed. For the present we have to be satisfied with less complete information. The existence of a succession of fungi on *Casuarina* leaf litter has been demonstrated by Burges (1951); others have shown similar successions of fungi (e.g., Kubiena, 1938).

The succession of animals which feed on litter is dependent upon the extent of its subdivision as well as on the degree of chemical decomposition which the litter has undergone. Romell (1935)

observed that millipedes only feed on plant tissue which has undergone a certain amount of decomposition by fungal action. The amphipod, *Talitrus sylvaticus*, feeds on leaves only after they have been on the ground for some months. The main groups of animals which feed on plant litter in its various stages of decomposition (group 3, Fig. 1) are oligochaetes, myriapods, crustaceans, and miscellaneous insects, amongst which ants and termites are important in some soils.

Oligochaetes

Two families are common inhabitants of leaf-litter and the associated soil: the Lumbricidae (earthworms) and the Enchytraeidae (white worms). White worms have been studied extensively in sewage beds, and in that environment they are algal feeders (Reynoldson, 1939a, b). Others which occur in leaf litter are said to attack living plants (Stirrup, 1913). Clark (1949) has observed that enchytraeids in plant litter in Australian rain forests eat finely divided plant remains. A considerable amount of fungal mycelium is ingested with these decaying tissues, and this possibly served as nourishment for the worms.

Earthworms play an important part in aiding the decomposition of plant litter and its incorporation in the soil. This was first clearly demonstrated by Darwin (1881). Their role in the incorporation of plant litter with soil was further demonstrated by Muller (1889). Since then, earthworms have commonly been regarded as the main organisms responsible for the "mull" type of humus of hardwood forests. In contrast, earthworms are usually absent from the "mor" type of humus of coniferous forests. In the "mull" the decomposed litter is typically incorporated with the soil, so that there is a gradual transition from freshly fallen plant litter on the surface to well "humified" soil beneath. But in the "mor" type of humus there is a clearer distinction between the mat of leaf litter and the mineral part of the soil. Bornebusch (1930) has pointed out the association of earthworms with hardwood "mull" in Denmark and their absence in coniferous forests. In the hardwood "mull" he found some species characteristically associated with the top raw humus, e.g., *Dendrobaena* spp., and others characteristically associated with the mineral part of the soil, e.g., *Allolobophora* spp.; deeper burrows were formed mostly by larger species of *Lumbricus*. In some places millipedes are known to be associated with "mull" formation. This is discussed in the section on myriapods. Earthworms eat fallen leaves on the surface and, as well, draw leaves into their burrows and eat them there. In the process of burrowing they also ingest soil. The result of this is a subdivision of the soil aggregates and the movement of the soil. Mechanical analyses of casts show that the soil which has passed through the alimentary canal contains a higher proportion of soil particles less than 0.002 mm. in diameter and a smaller proportion of larger particles, as compared with uningested soil (Blank and Giesecke, 1924).

The role of earthworms as soil movers was given prominence by Darwin, who calculated that in English meadows and gardens earthworms moved fourteen tons of soil to the surface per acre each year. Evan's more recent studies at Rothamsted have added renewed interest to Darwin's work. He found that the weight of worm casts produced per year on fields of different agricultural history varied from one to twenty-five tons (Evans, 1948). Differences from one field to another at Rothamsted were chiefly due to differences in the numbers of only two of several species of earthworms present: *Allolobophora noctura* and *A. longa*. The remaining species void the ingested soil into the spaces below the surface. Evans estimated that from four to thirty-six tons of soil passed through the alimentary tract of the total population of earthworms present in an acre in a year. The non-casting species are not effective in burying stones or raising soil to the surface. He considers that this difference in behavior, which was not known to Muller (1889) or Darwin (1881), accounts for some of the discrepancies in the conclusions of these two early workers.

In addition to the influence which earthworms have on the structure and composition of the soil through the decomposition and mixing of plant litter, their dead bodies release nitrates and other substances not yet completely identified (Hopp and Slater, 1949). In pot experiments Hopp and Slater have established that these processes have an over-all beneficial effect on the plant productivity of soil.

Earthworms do not feed indiscriminately on leaves. Given a selection of leaves from six different hardwood trees, *Lumbricus terrestris* showed a preference in the following order: larger toothed aspen, white ash, basswood, sugar maple, red maple. Red oak was not eaten at all (Gast, 1937). Different sorts of plant litter have different nu-

tritive values for earthworms. Evans and Guild (1948a) fed two species of earthworms in England on nine types of humus and recorded the effect on cocoon production. High cocoon production occurred in partially decomposed humus, and low production occurred in undecomposed and well-decayed humus. They found also that the addition of the same weight of straw to bullock droppings produced an increase of one hundred per cent in cocoon production.

Surprisingly little is known about the actual substances in plant litter which are digested by earthworms. Tracey (1951) reported the existence of cellulases in seventeen species of earthworms in Britain. In twelve of these species a chitinase was also present. The extent to which cellulose and chitin are digested remains to be found out. Nor do we know what happens to the lignin which is ingested.

In experiments in which millipedes were given the leaves of one sort of tree to eat, Van der Drift (1951) found that different quantities were eaten depending upon the species of the tree. Table 1 shows that *Julus* and *Cylindrojulus* ate small quantities of leaves from the surface leaf litter, but they ate much larger quantities of leaves which were a year old. *Julus* ate more red oak than any other type of leaf, whereas *Cylindrojulus* ate more pine. Table 1 also shows that the quantities of leaves eaten by these two millipedes and by *Glomeris marginata* were larger than the quantity eaten by the earthworm *Dendrobaena octaedra*. The smaller millipedes ate more in proportion to their body weight than the larger animals; for example, *Glomeris marginata*, of average weight of 52 mg., consumed tissue weighing 66 per cent of the body weight each day. Those with an average weight of 19 mg. each day consumed tissue weighing only about 36 per cent of the body weight.

TABLE 1

The Daily Litter Consumption in Percentage of Body Weight of Three Millipedes, an Earthworm, and a Tipulid Larva

(After Van der Drift, 1951)

SPECIES	AVERAGE WT. (mg.)	SURFACE LEAVES OF LITTER				LEAVES ONE YEAR OLD			
		BEECH	OAK	RED OAK	PINE	BEECH	OAK	RED OAK	PINE
Myriapoda									
Julus scandinavicus	60	8	8	3		16	22	31	17
Cylindrojulus silvarum	60	12	7	1	3	33	29	40	43
Glomeris marginata	150						26		
Diptera									
Tipula scripta	60					42			
Oligochaeta									
Dendrobaena octaedra	350					10			

Pauropods are present in humus in some soils in larger numbers than any other millipedes (Starling, 1944), but practically nothing is known about their feeding habits.

Myriapods

Romell (1935) considered that millipedes of the genus *Fontaria* were the main organisms responsible for the formation of a "mull" type of humus from the fallen needles in a white pine stand in the state of New York. In pot experiments he found that the millipedes did not ingest freshly fallen leaves which were unattacked by fungi. The same habit is recorded of the genus *Apheloria* (Eaton, 1943). These millipedes appeared to feed on fungal mycelium and partly decomposed leaf tissue. Millipedes, like earthworms, are not indiscriminate feeders. Lyford (1943) found a positive correlation between palatability and the calcium content of leaves eaten.

Crustacea

Isopods, particularly species of *Trichoniscus*, are widespread in forest soils. They play some part in the mechanical destruction of some of the more resistant plant tissues, but, so far as we are aware, no studies have been made of their digestive abilities. Franz (1951) showed that the alimentary canal of *Tracheoniscus* contains bacteria which can be cultured on nitrogen-free nutritive media;

he considered that these bacteria must therefore be able to fix atmospheric nitrogen.

The amphipod *Talitrus sylvaticus* is widespread in the leaf litter of tropical and subtropical rain forests on the eastern coast of Australia from northern Queensland to southern Victoria. These are usually present in tremendous numbers. In some rain forests near Sydney we have recorded as many as 4000 amphipods per square meter. They are a very conspicuous part of the fauna, both because of their numbers and also because of their habit of jumping when the litter is disturbed. They eat fallen leaves, and there is little doubt that they play a major part in the disintegration of leaf litter in Australian rain forests. In wet years they occur in the leaf litter of stands of timber in drier habitats such as *Casuarina*, *Eucalyptus*, and *Angophora* forests. But in most years the leaf litter in these forests is too dry for *Talitrus* to survive.

Ants and Termites

In some regions where earthworms are not abundant their role as earth movers is taken over by ants and termites (Branner, 1939). We, too, have noticed this in many dry savannah woodlands in Australia. Shaler (1891) estimated that in a field near Cambridge in England ants moved enough material to cover the surface soil with one-eighth inch of soil annually. Hopp and Slater (1949) found that ants produced an increase in crop yield in pot experiments similar to that obtained with earthworms. Since ants are either seed feeders or carnivorous, it is unlikely that they make much direct contribution to the degradation of leaf litter. Termites, on the other hand, digest cellulose and are responsible for the degradation of sticks and logs in the surface litter of the soil.

Oribatid Mites

Oribatid mites commonly occur in leaf litter. Riha (1951) studied the feeding habits of 14 species in leaf litter in a chalk soil in Austria. She found that 8 species fed on wet fallen leaves, and of these, 2 species were able to feed on wet dead wood, only 2 of the 14 species fed on fungal mycelia, 2 species fed on dead collembola and earthworms, and one species confined its feeding to wet dead wood and nothing else. The feces of the leaf and wood feeders contained small parts of undigested plant tissue. Other authors quoted by Riha have also found that most of the species of oribatid mites which they have studied from leaf litter feed on leaf tissue and not on fungal mycelia. But there are a few species which are fungal feeders (see below).

Molluscs

During a number of years of observation in rain forests in New South Wales we have not seen any appreciable numbers of land molluscs which feed on fallen leaves; the few species which are recorded as feeders of leaf tissue are extremely rare. But in deciduous forests in Europe molluscs may be quite important in decomposing leaves (Elton, pers. commun.). Lindquist (1941) determined the feeding preferences of 15 species of snails from a forest in Sweden. He kept the snails in vials with freshly fallen leaves from different forest trees and measured the amount of leaf tissue eaten each week for six weeks. All species rejected beech and tended to refuse oak, but those which fed on leaves at all fed mostly on leaves from soft-leaved trees like hazel, elm, and ash. Three of the 15 species favored leaf litter, 3 species favored green leaves exclusively, 10 other species tended to favor equally green leaves together with either leaf litter or fungi, and 2 species favored fungi more than anything else.

Other Animals

Little can be said about the other animals listed in Fig. 1 as plant feeders. Schaller (1950) found that the collembolan *Tomocerus flavescens* fed both on leaf tissue and the fungi of decomposing leaves, but was unable to eat fresh green leaves. When offered leaves of different trees, it fed more on elm and hornbeam than on oak and beech. All the other species which he studied fed on fungal mycelia and spores, algae, and small particles of detritus. Detritus had also been observed in the gut of collembola by other workers (Weis-Fogh, 1948; Clark, 1949). Some dipteran larvae have been regarded as litter feeders, for example, *Sciara* (Jacot, 1939), but the evidence for this is scarcely substantial. Larvae of the tipulid *Tipula scripta* eat leaves; Van der Drift (1951) found that larvae of an average weight of 60 mg. ingested 42 per cent of their weight of beech leaves per day. *Thrips* of the suborder Tubulifera are known to carry out their life history in leaf litter and have been said to be litter feeders (Tillyard, 1926). Other insects, such as members of the Blattidae and Dermaptera, feed on litter. It is unfortunate

that feeding studies on these and other animals have not kept pace with the numerous studies on the numbers of animals in soil and litter. There would seem to be little point in multiplying such census studies until more is known about the feeding habits of the animals counted.

B. Fungal Feeders

Some species of oribatid mites which occur in leaf litter feed on fungal mycelia (Forrslund, 1943; Van der Drift, 1951; Weis-Fogh, 1948; Riha, 1951). Many species of the collembola, commonly found in leaf litter, are known to feed on fungal hyphae, but whether this is the only item of their diet is not known. Other organisms, such as isopods and amphipods, probably consume fungal hyphae together with the leaf tissue they ingest, but, unlike some of the mites and collembola, they are not primarily grazers on fungal mycelia. Starling (1944) has stated that he has seen pauropods feeding on mycelia, but apart from this observation practically nothing is known of their feeding habits.

C. Bacterial and Algal Feeders

The greater part of the microfauna of the soil feed on bacteria. A smaller proportion feed on soil algae. There are three main groups of bacterial and algal feeders: protozoa, myxobacteria, and nematodes.

Protozoa and Myxobacteria

Most investigations on soil protozoa have centered on the possible effects of protozoa on the numbers of soil bacteria. Research was initially stimulated by the work of Russell and Hutchinson (1913) on "Soil sickness." This condition is common in heavily fertilized soils and is characterized by a high soil content of organic nitrogen and small numbers of bacteria. Since plants grow poorly in them, such soils are said to be "sick." Russell and Hutchinson found that partial sterilization of these soils, by chemicals such as formaldehyde or toluol, or by steaming, made them once again suitable for the healthy growth of plants. They concluded that the "sickness" was due to a reduction in the number of bacteria which normally break down organic nitrogen, and that this reduction was due to protozoa which fed on the bacteria. Sterilization was thought to kill the protozoa and so to enable bacteria to multiply once again. This hypothesis has been largely invalidated by the evidence of Waksman and Starkey (1923), who demonstrated that partial sterilization kills fungal mycelia and most of the soil actinomycetes as well as the protozoa. They considered that the carbon and nitrogen which had accumulated in the fungal mycelia became available to bacteria once the mycelia had been killed in the process of sterilization. More recently, Brian (1948) has suggested that "soil sickness" might be due to the effect on the bacteria of antibiotics produced by one or several members of the soil fungi and actinomycetes.

Interest in the theory of Russell and Hutchinson was stimulated by the discovery of Cutler, Crump, and Sandon (1922) that the number of bacteria and amoebae in soil fluctuated from day to day during a year in which they made daily counts of these organisms. Moreover, a decrease in the numbers of bacteria seemed to be associated with an increase in the numbers of protozoa, and vice versa. This inverse relationship between numbers of bacteria and amoebae suggested that the amoebae limited the growth of the populations of bacteria by their predation. But correlations do not, of course, imply causation.

The examination of bacterial numbers in field soil by Thornton and Gray (1930) showed that fluctuations could be detected within an 8-hour period when counts were made every two hours. These authors presented some evidence that numbers of different groups of bacteria underwent different types of fluctuations. They suggested that changes in the rate of fission of the bacteria may be one of the primary causes of fluctuations in their numbers.

Taylor (1936) also found that the numbers of different soil bacteria changed from hour to hour even when temperature and moisture were kept constant and protozoa were absent. Further research along different lines by Singh (1941, 1945, 1946a, b, 1947a, b, c) and by Hardin (1941) has shown that the relationship between bacteria and protozoa in soil is much more complex than was supposed by Cutler, Crump, and Sandon.

Singh studied the selection of bacteria as food by soil amoebae (Singh, 1941), myxamoebae of two species of slime molds (*Dictyostelium mucoroides* and *D. giganteum* (Singh, 1946a, b, c), and three species of predatory myxobacteria (*Myxococcus virescens*, *M. fulvus*, and *Chondrococcus exiguus*) (Singh, 1947a). The various soil amoebae which Singh studied showed definite preferences which were similar for different amoebae. These

preferences were neither related to the pigmentation nor the Gram staining reactions of the bacteria. On the other hand, myxamoebae of *Dictyostelium giganteum* and *D. mucoroides* showed a preference for gram-negative bacteria. Myxobacteria have a wide distribution in soils and occur in densities ranging from 2000 to 76,000 per gram of five predators. The number of strains eaten by each predator is shown in the contingency table (Table 2).

A comparison can be made between any two of the five predators, figures in heavy type showing the number of strains eaten in common by the two predators being compared. For example, *Leptomyxa reticulata* fed on 39 strains but rejected 48 strains, soil amoebae fed on 49 strains but rejected 38 strains, but only 28 strains were eaten in common by both organisms. Hardin (1941) has shown that the soil flagellate, *Oikomonas termo*, like these five predators, is also selective in its feeding on bacteria.

These studies all concern the various effects of soil (Singh, 1947a). They destroy bacteria by the production of a soluble non-enzymatic antibiotic substance and an extracellular lytic substance which, however, only lyses certain strains of bacteria previously killed by the antibiotic substance (Oxford and Singh, 1946).

Anscombe and Singh (1948) determined which of 87 strains of bacteria were consumed by each

TABLE 2

The Selection of 87 Strains of Bacteria Eaten by Each of Five Micropredators

(After Anscombe and Singh, 1948)

	LARGE SOIL AMOEBA			LEPTOMYXA RETICULATA			DICTYLOSTELIUM GIGANTEUM			MYXOCOCCUS VIRESCENS			MYXOCOCCUS FULVUS		
	NOT EATEN	EATEN	T	NOT EATEN	EATEN	T	NOT EATEN	EATEN	T	NOT LYSED	LYSED	T	NOT LYSED	LYSED	T
Leptomyxa reticulata															
Not Eaten	27	21	48												
Eaten	11	**28**	39												
Total for Soil Amoeba	38	49	87												
Dictyostelium giganteum															
Not Eaten	23	13	36	24	12	36									
Eaten	15	**36**	51	24	**27**	51									
Total	38	49	87	48	39	87									
Myxococcus virescens															
Not lysed	15	9	24	12	12	24	13	11	24						
Lysed	23	**40**	63	36	**27**	63	23	**40**	63						
Total	38	49	87	48	39	87	36	51	87						
Myxococcus fulvus															
Not lysed	23	16	39	27	12	39	22	17	39	18	21	39			
Lysed	15	**33**	48	21	**27**	48	14	**34**	48	6	**42**	48			
Total	38	49	87	48	39	87	36	51	87	24	63	87			
Gram stain negative	21	25	46	26	20	46	13	33	46	12	34	46	14	32	46
Gram stain positive	17	**24**	41	22	**19**	41	23	**18**	41	12	**29**	41	25	16	41
Totals	38	49	87	48	39	87	36	51	87	24	63	87	39	48	87

which protozoa and other bacterial feeders have upon soil bacteria. But soil bacteria also have a direct effect on protozoa. Some bacteria, for example, *Pseudomonas aeruginosa* and *P. pyocyanea*, produce substances which are toxic to some soil amoebae, flagellates, and ciliates (Singh, 1945). Several of the euglenid flagellates, most of which have been recorded from soil (Jahn, 1946, 1951; Sandon, 1927) do not prey upon bacteria but require vitamin B_{12} as a growth factor and are dependent upon certain bacteria in the soil, such as the Flavobacteria, to supply this (Lwoff 1951).

Not all soil protozoa are bacteria feeders. Many species e.g., *Amoeba verrucosa* and particularly the testate rhizopods such as *Difflugia constricta*, feed on soil algae. Testate rhizopods are relatively more abundant in acid soils (Sandon, 1927) and are the dominant amoebae in mosses (Fantham and Porter, 1945). Other species of protozoa are predatory on bacterial feeders (see section III, D).

These various modern studies show that the relationships between soil bacteria and protozoa are exceedingly complex and the problems associated with them are only likely to be solved by experiments with known species under controlled conditions in the laboratory.

Nematodes

The feeding habits of free-living soil nematodes have been the subject of a good deal of confusion and contradiction in the literature. Authors of texts on soil microbiology have frequently assumed that many of the soil nematodes feed directly on humus. The evidence for this is quite insubstantial (see Overgaard, 1949). Species which had previously been regarded as saprophagous, Overgaard found to be bacterial feeders. On the basis of gut analyses and cultures he recognized four feeding groups of nematodes present in soil (Overgaard, 1947, 1949):

(a) Plant juice feeders: the Tylenchinae and Hoplolaminae suck the fluid from roots of plants.
(b) Soil algae feeders: certain species of *Dorylamus* probably feed on algae as well as the cell sap of higher plants.
(c) Bacterial feeders: the Plectidae and *Rhabditis* are examples of bacterial feeders.
(d) Predatory nematodes, such as *Mononchus*, *Trilobus*, *Tripyla*, *Ironus*, and *Nygolaimus*.

From the works of various authors it is clear that most species of soil nematodes were once considered to decompose organic matter and so to play a role similar to that of soil bacteria. Overgaard (1949) has demonstrated that most of those he has studied in Danish soils feed on bacteria and not on humus. And, like the soil protozoa which feed on bacteria, the soil nematodes are probably selective feeders. Of 12 million nematodes per square meter recorded in a pasture soil, Overgaard found that 6 million were bacterial feeders. In raw humus the algal feeders dominated the bacterial feeders. The relative importance of protozoa and nematodes as feeders on bacteria is not yet known: Overgaard makes a provisional estimate of the influence of nematodes in Danish soils as 10 per cent of that of the protozoa.

D. Micropredators and Macropredators

Both the algal feeders and the bacterial feeders are preyed upon by various small organisms which we refer to collectively as micropredators (see Fig. 1). They include the highly specialized and extraordinary predatory fungi, the Hymenomycetes (*Dactylella*, *Dactylaria*, *Arthrobothrys*) which capture and digest nematodes and the Phycomycetes of the family Zoopagaceae which prey on amoeba (Dreschler, 1941). The only predatory animal amongst the micropredators which has been studied to any extent is the widely distributed nematode *Mononchus papillatus* (Steiner and Heinly, 1922; Thorne, 1927). It feeds on various species of soil nematodes. Besides *Mononchus* various species of protozoa and rotifers are micropredators. The ciliate *Spathidium* sp. preys upon *Colpoda cucullus*, which is particularly abundant in rain forest soils near Sydney in New South Wales. *Amoeba terricola* is said to feed on rotifers, especially species of *Mniobia* (Bartos, 1940).

Nor is much known about the role of the macropredators (group 7, Fig. 1) in soil. In total numbers, mites and insects are the main predators and, of these, the gamasid mites are probably the most important group. Other animals are listed in Fig. 1, but little is known of the part they play in the leaf-litter community. Fig. 1 could be extended to include such larger predators of insects as lizards and birds, but there is little point in adding to the list of predators while we know so little about them.

IV. DIVERSITY OF MICROHABITATS IN SOIL

Perhaps the most outstanding feature of the animal inhabitants of the soil is the extraordinary diversity of organisms which are found in it.

Practically every terrestrial invertebrate phylum is represented. The total number of different species in any one sort of soil must be quite immense; actual figures are difficult to quote since few workers identify all the species present. Sandon (1927) recorded 250 species of Protozoa alone in English soils. Macfadyen (1952) has collected 21 species of Collembola and 52 species of mites from a *Molinia* fen at Cothill, near Oxford in England, and 17 species of Collembola and 75 mites from an area of *Brachypodium pinnatum* grassland in Wytham estate near Oxford. These are minimal figures, as not all the species were identified. Frenzel (1936) recorded the number of species of soil animals exclusive of Protozoa in different habitats in Germany; the minimum number of species he found in any one habitat was 68, and the maximum 203. Williams (1941) gave a total of 294 species (exclusive of Protozoa) in a Panama rain forest. Both these records are almost certainly underestimates. Franz (1950) presented comprehensive tables of species found in soil in various habitats in Austria; in his table for beech woods at 1300 to 4500 feet he has listed 110 species of beetles, 229 species of mites, and 46 species of snails and slugs.

In the light of current ideas on the numbers of different sorts of animals in ecological communities (Elton, 1946), the diversity of species suggests a corresponding diversity of habitats. There is some evidence to suggest that two or more species which have closely similar requirements of food and type of place in which they live cannot survive together as persistent populations if resources of food and space are limited. This concept is relatively easy to test experimentally, since it is a simple matter to arrange laboratory models in which two or more species are made to utilize the same resources. But it is extremely difficult to obtain precise confirmation of the hypothesis in complex natural environments. One reason for this is the difficulty in identifying the different sorts of places in which animals live. It is not simply the sorts of differences between the spaces inside a hollowed twig and those between twigs, for example, that we have to look for, but the inside of a hollow twig may provide quite different conditions at different times of the day or the year. Despite the difficulty of identifying all the different habitats or "niches" in which animals live in soil, the large number of different species suggests that there may be at least as many different habitats where they can live.

The wealth of different habitats which can be occupied by animals in plant litter is associated with a number of features of this environment: the spaces of different size, the heterogeneous nature of the solid constituents of the litter, and the differences in microclimate from place to place and at different times of the day or year.

A. Spaces

The spaces between surface litter, the caverns walled off by soil aggregates, root channels, fissures, and pore spaces between individual soil particles are all potential habitats for animals. They differ in size and often in temperature and moisture. The pore spaces between particles of soil, soil aggregates, or leaf litter are filled with air in soils which are not water-logged. Usually they are lined with a thin continuous film of water which provides another habitat for soil organisms.

Most soil arthropods live in the air spaces of soil. The larger arthropods, such as amphipods and isopods, burrow and make their own tunnels but small arthropods, such as mites and collembola, cannot burrow in this way. The structure of the soil is therefore important in determining the distribution of these small forms in different soils (Weis-Fogh, 1948). Large collembola, such as *Isotoma viridis*, are restricted to leaf litter at the surface, whilst the smaller species such as *Tullbergia krausbaueri* and *T. quadrispina* inhabit the deeper soil (Weis-Fogh, 1948; Frenzel, 1936). Neither these two species nor *Onchiurus armatus*, which is also subterranean, occur in soil with a high clay content (Glasgow, 1939); this is no doubt due to the small pore spaces in clays.

The majority of the soil organisms (both in total numbers and numbers of species) are active only in the soil water. This is usually present as a thin film lining the surfaces of the soil particles. It contains bacteria, unicellular algae, protozoa, rotifers, nematodes, and other organisms. With the exception of nematodes and possibly bdellid rotifers, animals of the microfauna are restricted in their movements by the thickness and shape of the water film in which they live. Swimming forms are relatively small; for example, the flagellate *Oikomonas termo* has a maximum diameter of 20 μ. Ciliates occur as dwarfed forms; Koffman (1934) found that *Colpoda steinii* was only 18 to

22 μ long in soils, whereas in cultures it attained a length of 60 μ. Lund (1945) has given ample evidence of "dwarfing" in soil diatoms when these are compared with freshwater forms of the same species. Forms which require solid surfaces over which to move can usually accommodate their shape to surface irregularities. It is possible for them to be larger than the swimming forms and still to live in the water film. Included in this group are the ameoboid organisms, hypotrichous ciliates, and myxobacteria.

Nematodes are only active in soil water, but they are less restricted in their movements than protozoa; they can distort the surface of the water film in which they are swimming by muscular movements, and in this way bridge intervening air spaces. However, the short fusiform nematodes, such as species of *Criconemoides*, possess only weak powers of locomotion; this probably accounts for the discontinuous distribution of these forms in rain forest soils in New South Wales (Clark, 1949).

Protozoa, nematodes, and rotifers are able to encyst or enter a dormant state when the film of water in which they live dries out. They soon revive when free water again becomes available. A fallen leaf soon acquires a population of these animals when it becomes wet.

B. Heterogeneity of solid constituents

The relative amounts of plant litter and mineral matter vary with depth, and less decomposed litter tends to be near the surface. This heterogeneity of the soil provides a variety of habitats in which animals live and is doubtless responsible for the characteristic discontinuity in distribution of so many soil organisms. Very few organisms have a random distribution in the soil. Jones and Mollison (1948) found that the bacterial colonies and mycelia conformed to a Poisson distribution. The numbers of bacteria per colony conformed to a logarithmic series. Nematodes (Overgaard, 1948; Clark, 1949), collembola (Glasgow, 1937), and earthworms (Guild, 1952) are non-randomly distributed. We have counted over 3000 collembola on single leaves (80 sq. cm.) of *Sloania* in rain forest leaf litter; but leaves a few inches away, in a different stage of decomposition, had none on them.

C. Seasonal changes in soil habitats

Diurnal and seasonal changes in the weather are reflected in changes in the temperature and moistness of soil. Fluctuations are greatest at the surface but decrease with depth. The seasonal fluctuations in numbers of different species of organisms which inhabit litter and soil have been studied by a number of authors; they find that some species are characteristically abundant in summer and others in winter (see e.g., Thompson, 1924; Baweja, 1939; Pearse, 1946; Williams, 1941; Starling, 1944; Weis-Fogh, 1948). In *Casuarina* leaf litter near Sydney there is an almost complete disappearance of arthropods in the hot summer months, particularly in dry seasons (Clark, unpub.).

V. APPROACH TO THE QUANTITATIVE STUDY OF THE ROLE OF ORGANISMS IN SOIL

If we are to understand the processes which go on in a community of organisms such as those which occur in soil, we must know the feeding habits of the different organisms. From this information a "food-web" might be constructed which would show the food chains in the community. Not enough is known about the habits of organisms in plant litter to enable us to construct a "food-web" diagram, but we have seen in Section II how it is possible to make some broad divisions of the organisms into different feeding groups. The next step in our analysis is to try and find out the relative roles of these different feeding groups. We would like to know, for example, just what proportions of the plant litter, in all its various stages of decomposition, are utilized as food and are therefore broken down by the three major groups of feeders on plant litter: the fungi, the bacteria, and the animals (see Fig. 1). The litter all disappears eventually, so we presume that these three groups of organisms together convert plant litter into mineral matter. We would, of course, like to know which bacteria, fungi, or animals are responsible for most of the transformation, and the relative roles of the other organisms.

A knowledge of the relative numbers of individuals in each feeding group or of each species does not help us much; fungi cannot be measured in numbers like bacteria and animals. But apart from this difficulty the same numbers of small and large organisms obviously do not have equivalent effects in the community. The relative weights of the different organisms present in leaf litter during a specified period such as a year, or as is more

usually measured, the average weight of all individuals present during a year, may be a better index. But even that is quite inadequate, since different organisms vary tremendously in the amount of leaf litter they utilize for the production of the same weight of body tissue. An animal which derives all its energy from leaf litter and which has, in addition, a high respiratory rate will destroy more leaf litter than another animal similar in all respects, except that it has a lower respiratory rate (see Macfadyen, 1948).

Instead of considering the weight of leaf litter which is transformed, it is altogether more satisfactory to consider it as a quantity of energy (as calories, for example), some of which becomes transformed into heat (through the respiration of organisms which utilize it as food) and some of which becomes transformed into the energy of living tissue of these various organisms. The advantage of this approach is that the various transformations to heat and to the tissue of organisms can be expressed in common units: calories. But the problem is not as simple as that. For when we come to measure the amount of energy of plant litter converted into heat or tissue of decomposers during a year, we shall have to take into account those organisms which were never counted in our samples because they were eaten by predators or died from non-predatory causes. That is to say, we must know the amount of energy of leaf tissue which became transformed during the period of study into the tissue of decomposers or was lost in their respiration. We also need to know the amount of decomposers which was transformed into the tissue of predators or was lost in their respiration. Thirdly, we need to know the amount of energy represented by the decomposers which died from non-predatory causes.

Thus, in order to answer the question as to how much plant litter becomes transformed by the different decomposer organisms, we have to know the amount of energy which "flows" through the various feeding groups in the course of a year or whatever period of time is chosen for study. The first attempt at this type of analysis for any community was made on lakes in northern Germany by Thienemann (1918). The initial source of energy in a lake community is the sun, some of whose radiant energy is trapped by phytoplankton and water plants, which constitute the first trophic level in the "food-web" of the community. In the leaf litter community the plant litter corresponds to the living plants and phytoplankton of lakes, for it is the first trophic level of the community. Thienemann's concepts were developed by Lindeman (1942) in his study of lakes in Wisconsin, and more recently Clarke (1946) applied the same concepts to a marine environment. This approach to the study of ecological communities which Allee et al. (1949) call "community metabolism" is unquestionably one of the most difficult and challenging studies confronting the present day ecologist.

As yet, few attempts have been made to study the "flow" of energy within terrestrial communities. The inhabitants of the plant litter and soil lend themselves to such an approach, perhaps more than other natural groups of terrestrial organisms. Bornebusch (1930) and Overgaard (1949) in Denmark have made considerable contributions to our knowledge of the "flow" of energy through certain organisms in the soil and plant litter. This is considered below.

The complete study of the "flow" of energy through the organisms in leaf litter would be an immense task. The data which are at present available are far from adequate, but it seems worth while to outline the problem as a whole, even though we shall only be able to fill in parts of it. The diagrammatic representation of feeding groups in Fig. 1 is represented quantitatively by what we might call an "energy diagram" in Fig. 2. In Fig. 2 the length of the base line represents the amount of leaf litter (in calories) which falls to the ground during a year in a forest. It is not unreasonable to suppose that about the same amount of plant litter is present at the end of the year as at the beginning. The length of the base line will then represent the amount of plant litter in calories which is turned into heat or the tissues of organisms during the year. The channels of this transformation of energy are shown in the first "step" of the diagram ("decomposers"). Some of the energy is represented by the total amount of living tissue produced by the decomposer organisms during the year (A_1); some by energy which is lost as heat in respiration (R_1). The energy transformed into living tissue (A_1) has three possible fates:

(a) Some of these organisms will die without being preyed on by other organisms (non-predatory mortality, NPM_1), and the calories of their tissues will return to the leaf litter in the form of their dead bodies.

(b) A second proportion of the decomposers will have been preyed upon and digested by other organisms during the year. This we shall call predatory mortality (PM_1).

(c) The rest of the decomposers are those which escaped death during the year. The total energy of their living tissues corresponds to what limnologists call the "yield" or "uncorrected productivity" (see Lindeman, 1942). It is called "uncorrected productivity" because it does not take account of the energy lost in respiration and in the death of organisms. It is simply the annual "yield" of living tissue which would be measured by the usual census methods, which take no account of dead organisms. These terms have a particular appropriateness in limnological studies, since the PM_1, Fig. 2) is in principle the same as that of the decomposer organisms. Some is lost in respiration (R_2). Some is transformed into tissue of predators (A_2): some of this is locked up in organisms which die from non-predatory causes (NPM_2) and some in organisms which escape death (UP_2). The rest is ingested by secondary predators, and a portion (A_3) becomes the tissue of a secondary group of predators. The indigestible portion of this is represented as F_3. We have introduced a considerable simplification by supposing that all predators can be divided into primary and secondary, and if need be, tertiary predators; some predators are indiscriminate and feed on decomposers as well as on other predators.

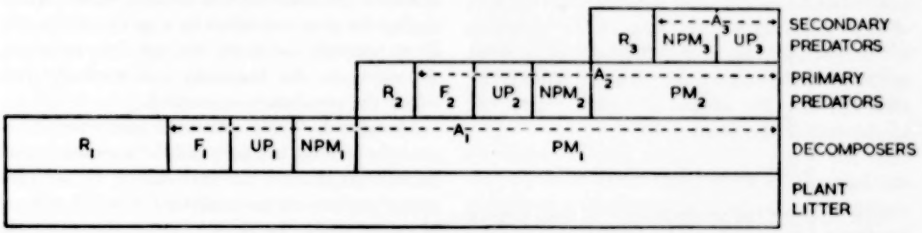

FIG. 2. ENERGY DIAGRAM FOR ORGANISMS LIVING IN PLANT LITTER
(For explanation see text)

A, living tissue; *PM*, predatory mortality; *NPM*, non-predatory mortality; *UP*, uncorrected productivity; *F*, feces; *R*, respiratory losses; *B*, energy transformed into living tissue. Subscripts 1, 2, and 3 refer respectively to decomposers, primary predators, and secondary predators. It should be noted that in each case *F* refers to the feces of the next trophic level; e.g., F_1 are feces of primary predators (at one stage living tissue of decomposers).

organisms concerned, for example fish, are sometimes "harvested." The terms are somewhat less appropriate for the soil community but nevertheless we use them for consistency, as the parallel with the lake community is close. "Uncorrected productivity" or "yield" is shown as UP_1 in Fig. 2.

Not all the tissue which is ingested by primary predators is utilized by them. Some of it is indigestible and is returned to the plant litter as feces (F_1). F_1 represents the indigestible fraction of the tissues of decomposer organisms which is ingested by predators. Although F_1 represents the feces of predators it is more appropriately shown in Fig. 2 in the second step of the diagram (labelled "decomposers"), since it was at one time the energy of decomposer organisms before they were consumed by predators.

The fate of the tissues of decomposers which were *digested* by primary predators (shown as

The error involved in this simplification would need to be considered in any particular study.

The relative lengths of the horizontal sections of Fig. 2 have no quantitative significance. The sections representing predatory mortality are larger than the others for the convenience of subdivision of the diagram at higher trophic levels. We shall see in Section V, F that the parts of the diagrams shown as respiratory losses (R) are in fact likely to be the largest parts at each step. We have already indicated that the experimental work involved in obtaining the quantitative information for Fig. 2 would be tremendous. But, although this might be the ideal objective of the ecologist, a great deal would be gained if such data were obtained for even one chain of organisms in the "food-web." The diagram is applicable in principle to one chain of organisms just as much as to the whole community. If we wished to compare the relative importance of earthworms and amphipods in rain

forest soil, it would be necessary to obtain some sort of quantitative information for each step in the diagram for the food chains of each of these organisms. The data which we would have to obtain for constructing such a diagram for one chain of organisms, or for the whole community, are discussed in the sections which follow.

A. Total Plant Litter Decomposed during a Year

The base line in Fig. 2 represents the amount of energy of plant litter at the beginning of the year. It is no longer plant litter at the end of the year, for it has become transformed into energy of living organisms, feces, dead organisms, and heat. A rough index of the amount of organic matter converted to mineral matter during the year could be obtained by measuring the amount of organic matter per unit area at the beginning of the year, adding to this the total plant litter falling onto the area in the year, and subtracting from the total the amount of organic matter left at the end of the year.

B. "Uncorrected Productivity"

The "uncorrected productivity" at each trophic level stands for the estimate which is made from field census studies of the weight and energy content of living organisms produced during the year of study. This estimate will vary with the method of census and the frequency of census. If the census is infrequent, it is likely that animals which may have been counted alive under more frequent census will be missed because they have died. These will then be included in the estimate of mortality. In actual practice, estimates are made of organisms present at regular intervals during the year. It is assumed that the weight at the time of the estimate represents the weight of organisms present in the interval between estimates. It will, of course, have varied depending on relative birth and death rates during this interval, but the error involved in neglecting this will not be great if the population estimates are made at sufficiently frequent intervals. Now, although we take the weight of organisms at the time of sampling as representing the weight present during the interval between samplings, this weight is not necessarily the uncorrected productivity for this period. It is possible, for example, that two generations of an organism may have been completed in this time, in which case uncorrected productivity would be twice the weight of organisms found at the time of sampling. The determination of annual "uncorrected productivity" is at its simplest in the case of organisms which have only one generation in a year, for example, some oribatid mites (see Weis-Fogh, 1948). But many animals in plant litter probably have more than one generation in a year, for example, many collembola (Weis-Fogh, 1948) and some earthworms, of which *Lumbricus castaneus* is an example; quite a number of earthworms take over a year to complete their development (Evans and Guild, 1948a). Unfortunately little is known about the generation times of the fauna of plant litter; it probably varies in different years. In the absence of this information various approximated estimates of uncorrected productivity will probably suffice for most purposes. A crude estimate would be the main mass of living animals present during the year multiplied by a generation factor. More accurate estimates can certainly be made, depending on the frequency and accuracy with which the population is sampled.

Bornebusch (1930) estimated quantities of organisms or what has been called "standing crops" at different times of the year, but he did not estimate "uncorrected productivity." His calculations of energy utilization do not include the calories in the mass of living tissue of organisms, but only the calories lost through respiration. The relative importance of this omission will be considered in the section on respiratory losses.

C. Non-predatory Mortality

The estimation of non-predatory mortality presents one of the most difficult problems in productivity studies. Lindeman (1942) ignored it entirely in his study of lakes in Wisconsin. One of the few attempts to measure non-predatory mortality of any population was made by Borutsky (1939) in his study of *Chironomus plumosus* in the bottom of Lake Beloe. He estimated that 855 kilograms of dry weight of *Chironomus* died naturally each year for every 440 kilograms consumed by predatory animals. The disproportion between predatory and non-predatory mortality in the fauna of humus might be even more in favor of non-predatory mortality, if we can judge by the relatively small weight of predatory organisms as compared with decomposer organisms in the ten habitats studied by Bornebusch (1930). The student of the fauna of plant litter has to be careful to remember that he usually only counts the animals which he sees alive, whereas in the times between his

sampling, animals have died and are never collected.

D. Predatory Mortality

The amount of energy which is lost through predators is most conveniently considered by beginning with the highest trophic level. The sum of $R_3 + NPM_3 + UP_3$ for secondary predators gives the predatory mortality of the primary predators and so on.

E. Feces

Following limnological procedure, the feces might be determined indirectly on the basis of the constituents of humus which are indigestible for decomposers, the indigestible constituents of decomposers for primary predators, and the indigestible part of primary predators for secondary predators (Lindeman, 1942). In Fig. 2, F_1 for example represents the quantity (in terms of energy) of indigestible decomposer tissue associated with the production of A_2 primary predator tissue. Estimates of digestibility clearly involve a knowledge of the digestive capacity of animals in each trophic level, a knowledge which we do not at present possess. We do not know, for example, which animal decomposers can digest lignin; yet lignin disappears. This may be due solely to the activities of the fungi and bacteria, or animals may play a part as well.

F. Respiratory Losses

The energy of plant litter is converted into heat by the metabolic activity of living organisms. This is shown in Fig. 2 as R_1, R_2, and R_3. The quantity R_1 represents the energy lost as heat by the metabolism of all the decomposer organisms which were produced from the plant litter in one year. In other words, it is the respiratory losses associated with the metabolism of living tissue A_1. Now it can be seen from Fig. 2 that $A_1 = PM_1 + NPM_1 + UP_1 + F_1$. Similarly R_2 represents the energy lost as heat by the metabolism of all the predators which were produced from decomposer tissue in one year, represented by A_2; and $A_2 = PM_2 + NPM_2 + UP_2 + F_2$. Similarly R_3 is metabolic loss associated with the production of A_3, and $A_3 = PM_3 + NPM_3 + UP_3 + F_3$. The exact constitution of R_1, R_2, and R_3 is a little subtle. We cannot ignore the respiratory losses of animals which have been eaten by predators and hence never counted or weighed. They nevertheless contributed their share to respiratory losses whilst they were alive. In Lindeman's (1942) study of lakes, which is the only one which attempts any completeness, this was not appreciated. In estimating respiratory losses Lindeman took account only of the respiratory losses associated with the annual "uncorrected productivity" (UP). With Lindeman, R is the loss associated with UP, whereas it should be the loss associated with $UP + NPM + PM + F$. Since Lindeman did not measure non-predatory mortality it is not possible to estimate the associated respiratory losses. Calculations for respiratory losses associated with PM and F result in corrections to R for "primary consumers" in Lindeman's Table 2 of the order of 40 per cent, and a correction of 25 per cent for "producers." The resulting correction to Lindeman's total "corrected productivity" of "producers" is of the order of 4 per cent, which happens in this case to be negligible.

Bornebusch's (1930) estimate of the total energy utilization of animals which decompose leaf litter was obtained by determining the respiratory losses associated with the mean "standing crop" of animals during the year. In terms of Fig. 2 his estimate would represent a part of R_1, whereas a complete estimate of energy used in the year would have given the sum of $PM_1 + NPM_1 + UP_1 + R_1$. His estimate of R_1 is incomplete, as it is based on the respiratory losses associated with UP and not the complete losses, as explained earlier. The error involved in limnological studies by neglecting these additional items would be great; that is, provided we can accept Lindeman's (1942) figures as a guide. And this is because the yearly respiratory losses which Lindeman gives are of the same order of magnitude as the amount of energy turned into living tissue during the year. It has been pointed out to us by Macfadyen of the Bureau of Animal Population, Oxford, that the amount of energy liberated by organisms which live on leaf tissue must be very much greater than the amount of energy locked up in their tissues. Unfortunately, full figures are not available for these animals. Macfadyen (pers. commun.) made a rough estimate for nematodes based on figures of Overgaard (1949); one nematode liberates about its own calorific value of energy in 33 hours, and as they live several months the ratio of respiratory losses to calories locked up in tissues must be of the order 50:1. Similar rough estimates based on

Bornebusch's (1930) figures for a staphylinid beetle indicate that the adult beetle liberates its own calorific value of energy in 6 days; they probably live for a year at least. This again suggests a ratio between energy lost and energy locked in tissue of about 50:1. If these estimates prove to be of the right order, it is clear that no great error is involved in ignoring the calories locked up in body tissues.

Bornebusch (1930) estimated respiratory losses in the following way. He determined the rate of oxygen consumption of 26 species of soil animals at one temperature, 13°C. These animals varied in size from animals as large as earthworms to those as small as collembola. He concluded from his results that the respiratory rates of these animals were proportional to their surface area, which in turn was proportional to $\sqrt[3]{W^2}$ where W is the weight of the animal. The conversion from weight to surface area is desirable, since the animals are normally weighed. The average oxygen consumption per gram for the 26 species at 13°C. was 0.14 mg. per hour. From the mean weight of each species and the total number present in a year, Bornebusch obtained a figure for the total weight of living animals present in a year. The respiration rate of this bulk of animals at 13°C. was derived from his estimates of oxygen consumption of 26 species at 13°C. This was converted to a rate of respiration at the "mean temperature for the year" by using a generalized curve expressing the effect of temperature on rate of respiration of several animals. Three sources of error are involved in these approximations which Bornebusch made, and until we know more about the respiratory rates of soil organisms it is difficult to gauge the total error involved in his calculations. The three sources of error are as follows: (i) The respiratory rates of the soil organisms were assumed to be proportional to their surface area at any one temperature. But even one species in two different places may have a different respiratory rate in each place; such differences are known to be genetic in some cases, others to be due to acclimatization. There is some evidence from studies on various insects, for example, that the respiratory rates at any one temperature are related to the average temperature of the environment in which the animals normally live (Ide, 1935; Birch, 1945). (ii) The relationship between temperature and the rate at which the oxygen consumption of animals changes was assumed to be the same for all poikilothermic animals in the leaf litter. Although data on soil animals are not available, it is known that species of other insects differ considerably in these respects (e.g., Birch, 1947). (iii) Bornebusch assumed that the total respiration of animals in a year could be estimated from the mean number of organisms present in a year and from the mean temperature. Calculations of rates from mean temperatures when the animals experience fluctuating temperatures involve large errors; see, for example, the detailed discussion of the sources of errors for the rate of development of grasshopper eggs in the field, by Andrewartha (1944). It is not unreasonable to suppose that errors of a similar magnitude are involved in estimates of respiration based on mean temperatures. What is needed is a record of the daily fluctuations of temperature in the leaf litter during the period of study and a knowledge of the precise relationship between rate of oxygen consumption and temperature. Graphical (see Andrewartha, 1944) or other mathematical methods can then be used for integrating the two sets of data.

In outlining this general approach to the study of the role of the organisms in plant litter we have seen the tremendous difficulties involved in obtaining anything like a complete picture. Not all the information is equally easy to collect; it is possible that work in the future may show that some of the items in the complete balance sheet of where the energy goes may not be important and can safely be neglected. This will reduce the amount of work which will have to be done in providing an adequate picture for any community, but we are hardly yet in a position to choose what to discard and what to retain as essential items of study.

VI. ESTIMATES OF THE RELATIVE ROLES OF DIFFERENT ORGANISMS

Unfortunately few estimates of respiratory rates of organisms which live in plant litter have been made, despite the rather numerous studies on the numbers of organisms in these environments. Although numbers without respiratory rates can be misleading, a summary of some of the more reliable estimates of numbers of animals found in soil and plant litter are given in Table 3. Information for pastures as well as forest soils is given. The table does no more, perhaps, than emphasize the tremendous numbers of organisms in soil and plant litter. Most is known about the nematodes, earth-

worms, and arthropods, and we shall now proceed to discuss these.

A. Nematodes

Overgaard (1949) introduced the first satisfactory method for sampling soil nematodes. He studied 31 localities in Denmark and found the numbers to vary from 708 million per acre to 81,000 million per acre. He determined the number and weight of the four different feeding groups (see Section III, C) in each of his samples and as well the oxygen consumption of each group. The percentage importance of each group relative to the others could be expressed in terms of numbers, weight, and energy utilization. Such data for his lowest and highest counts are shown in Table 4.

Grass fields harbor the densest nematode fauna (4 to 20 million per square meter), while in all other localities the numbers do not exceed 2.5 million. Within smaller populations (175,000 to 800,000) the bacterial-feeding nematodes constitute only 7 per cent of the total weight of nematodes in the soil. In soils with denser populations (10 to 20 million) the bacterial feeders constitute 47 per cent of the total weight. Within these two groups the percentage weight of algal feeders decreases from 88 per cent to 28 per cent. In raw humus (1.2 to 2. 7 million) bacterial feeders constitute

TABLE 3

Numbers and Weight of Animals in Soil and Plant Litter

ORGANISMS	NUMBERS		WEIGHT		REMARKS	SOURCE
	PER SQ. METER	PER ACRE	GRAMS PER SQ. METER	LBS. PER ACRE		
Protozoa			29 – 57	255 – 510	Rothamsted soil to depth of 9 in.	Russell (1923)
Nematodes	175,000 – 20×10^6	708×10^6 – $81,000 \times 10^6$	1 – 17.8	9 – 159	Danish bare slope and grass field, respectively, to depth of 5 cm.	Overgaard (1949)
Arthropods	264,000	$1,068 \times 10^6$			Cambridgeshire pasture to depth of 12 in. Maximum number ever recorded.	Salt et al. (1948)
	60,400	245×10^6			Oxfordshire meadow.	Ford (1935)
Enchytraeidae (pot-worms)	148,100	600×10^6			Swiss soil	Jegen (1920)
	91 – 782	369,000 – 3.2×10^6	0.05 – 1.56	0.45 – 14.0	Danish spruce raw humus and beech raw humus, respectively.	Bornebusch (1930)
Lumbricidae (earthworms)	18 – 358	73,000 – 1.5×10^6	0.90 – 200	8 – 1786	Spruce raw humus and Danish oak mull (80 cm.) Earthworms were dug from soil.	Bornebusch (1930)
	17 – 190	69,000 – 770,000	18.8 – 163	168 – 1456	Rothamsted arable field and 300-year old Rothamsted permanent pasture, respectively. Earthworms were brought to surface with potassium permanganate.	Evans and Guild (1948b)

21 per cent of the nematodes, and algal feeders 57 per cent. In all these cases comparisons based on respiration figures are essentially similar.

On the average one-third of the nematode population is composed of bacterial feeders. Of the 17.8 grams of nematodes recorded in Table 3, about 8 grams constitute bacterial feeders and are to be compared with figures of 29 to 57 grams for protozoa. So far as we know, no respiratory figures are available for soil protozoa, nor is it possible to quote the proportion of bacterial feeders among them. But if the relative roles of protozoa and nematodes is in proportion to their weights, it is evident that nematodes consume about one-tenth of the number of bacteria consumed by protozoa.

lation of a permanent pasture did not appreciably change for the period of three years during which their study was made.

Earthworms in a rich Danish mull constitute about 80 per cent of the total weight of the fauna. Bornebusch estimated that this represents only 60 per cent of the total oxygen consumption of the fauna. In beech raw humus, where earthworms constitute 22 per cent of the weight of the fauna, they represent only 12 per cent of the total oxygen consumption. In this same humus the very small arthropods, mites, and collembola constitute 2.3 per cent of the total biomass, but account for as much as 16.1 per cent of the total respiration. This suggests that in spite of their small aggregate

TABLE 4

Numbers, Weight, and Respiration of Nematodes from Two Contrasting Soils in Denmark

(Selected from Table 25, Overgaard, 1949)

	NUMBER PER SQUARE METER						WEIGHT PER SQUARE METER						RESPIRATION PER SQUARE METER					
	Total number in 1,000's	% bacterial feeders	% root suckers	% algal feeders	% predators	% food unknown	Total weight in grams	% bacterial feeders	% root suckers	% algal feeders	% predators	% food unknown	Total O_2 consumption per hour at 16°C.	% bacterial feeders	% root suckers	% algal feeders	% predators	% food unknown
Bare Slope.....	175	11	6	81		2	1	1	1	98		<1	0.6	<1	<1	>99		<1
Grass Field.....	20,000	50	39	2	1	8	17.8	47	22	21	7	3	17.3	56	18	17	6	3

B. Oligochaetes

The total weight of earthworms in soil and humus is in general far greater than that of enchytraeids (see Table 3). Bornebusch (1930) found a tremendous variation in the biomass of earthworms in the ten forest localities he studied in Denmark. The lowest was recorded from spruce raw-humus (0.90 grams per square meter). The maximum number and biomass were recorded from a rich oak-*Mercurialis* mull soil. The biomass of earthworms per unit area in this soil was equivalent to the biomass of livestock on the same area of a first-class Danish farm (200 grams per square meter). Evans and Guild (1948b) recorded a maximum biomass of earthworms of 1,456 lbs. per acre (163 grams per square meter) on a 300-year-old pasture at Rothamsted. This is considerably smaller than the maximum recorded by Bornebusch for forest soil. They showed that the popu-

weight these small organisms may be of considerable significance in the decomposition of organic matter.

The oxygen consumption of nematodes is ten times that of the same weight of earthworms (Overgaard, 1949). Such figures emphasize the desirability of basing comparisons on energy utilization rather than on weight alone.

C. Arthropods

The critical study of soil arthropods followed the development of the Berlese funnel technique for extraction of soil fauna in 1905. Berlese's original method has been modified by various workers (e.g., Haarlov, 1947). The development of these techniques up to 1947 has been reviewed by Fenton (1947). Because of the continual improvement in extraction techniques, modern studies are more accurate than earlier ones. It is significant that the

most recent estimate of the soil arthropods is the highest yet recorded, namely, 1069×10^6 animals per acre in a Cambridgeshire pasture (Salt et al., 1948). The previous densest population known was Ford's (1935) estimate of 244.8×10^6 insects in an Oxfordshire meadow.

The majority of arthropods are small. Salt et al. (1948) estimate that they occupy 1 part in 20,000 of the gross space of the soil. They point out that this is a much greater proportion of space than has been estimated to be occupied by the micro-organisms of the sea.

The collembola and mites are always the dominant arthropods in soil and humus. Salt et al. (1948) estimated that they constitute six-sevenths of the total number of animals in the soil, the mites being dominant. These figures can be compared to the estimates of Weis-Fogh for a series of localities in Denmark (Table 5). Bornebusch (1930) found that the numbers of mites and collembola varied from 1,000 to 10,000 per square meter (depth same) in the ten forest localities studied, being greatest in raw humus. The very much smaller numbers are partly accounted for by imperfect extraction. According to Trägårdh and Forsslund (quoted by Overgaard, 1949), Bornebusch only recovered 10 per cent of the mites and 27 per cent of the collembola present; even so they constituted 2.3 per cent of the total weight of the fauna and 16 per cent of the total oxygen consumption.

In the same depth of Danish pasture soil referred to in Table 5, 72 per cent of the mites and collembola occur in the top centimeter and only 4 per cent occupy the bottom centimeter. In the raw humus (Table 5) 25 per cent of the mites and collembola occupy the bottom centimeter of the 5 cm. sample. In a transect across the pasture Weis-Fogh (1948) found that collembola decrease and oribatid mites increased from the drier to the moister end.

D. Total Weight of Organisms in Single Habitats

A picture of the energy relationships which attempts any degree of completeness must be drawn from data from single habitats. A complete study of energetics on the lines suggested in section V of this paper has not so far been done. Williams (1941) presented a pyramid of numbers for animals in the floor fauna of a Panama rain forest showing the dominance in numbers of small forms, mostly non-carnivorous, and the smaller number of larger forms, mostly carnivorous. Reasonably complete estimates of the biomass have been made in a few cases. Overgaard (1949) has summarized a table of Stöckli for a grass field giving "average" populations. This is reproduced in Table 6.

The micro-flora of Table 6 constitute 80 per cent of the total weight, the microfauna constitute about 2 per cent. This would suggest that the fauna plays a small role by comparison with the

TABLE 5

Numbers of Mites and Collembola in Various Habitats

HABITAT	NO. PER SQ. METER	NO. PER ACRE IN MILLIONS	DEPTH	SOURCE
Cambridgeshire pasture				
Mites and Collembola	225,632	915	12 cm.	Salt et al. (1948)
Danish pasture				
Mites and Collembola	166,000 – 438,000	673 – 1,958	5 cm.	Weis-Fogh (1948)
Raw humus on a heather hill				
Mites and Collembola	402,000	1,630	5 cm.	Weis-Fogh (1948)
'Molinia' fen near Cothill in England				
Collembola	25,200 (320.7 mg.)	102	5 cm.	Macfadyen (1952)
Oribatid mites	127,700 (1305.1 mg.)	518	5 cm.	"
Other mites	15,000 (201.3 mg.)	61	5 cm.	"

flora in the decomposition of humus, assuming that the majority of the organisms in the microflora are decomposers. Protozoa constitute 86 per cent of the microfauna, nematodes 10 per cent, and microarthropods the remainder. The macrofauna constitutes about 18 per cent of the total biomass.

Data for two contrasting habitats among ten habitats studied by Bornebusch (1930) are summarized in Table 7. Bornebusch excluded the microflora, protozoa, and nematodes from his study. A figure for nematodes in the spruce raw humus habitat is provided by Overgaard (1949), and this is included in the table. The figures for the acarina and collembola have been corrected as suggested by Overgaard (1949). In the spruce raw humus the microfauna, even without the protozoa, is much more important in relation to the macrofauna than in the grass field or the oak-*Mercurialis* mull. This is associated with the much smaller weight of earthworms. The greater number of mites and collembola is characteristic of raw humus.

TABLE 6

Weight of Organisms in Natural Grass Field in Switzerland, to a Depth of 15 cm.

Table modified from Stöckli as quoted by Overgaard (1949).

	GRAMS PER SQ. METER
Microflora (bacteria, actinomycetes, fungi, and algae)	2021.9
Protozoa	37.9
Nematodes	5.0
Enchytraeids	1.5
Earthworms	400.0
Mites, Collembola, Protura, Diplura	1.1
Other invertebrates	79.7
Total	2547.1

In the mull humus of broad leaf forests such as oak and beech, Bornebusch's figures show that earthworms constituted from 50 per cent to 80 per cent of the total weight of fauna. Most of the arthropods were millipedes and collembola. About the same total weight of each was present. The greatest numbers of animals were found in raw humus. Beech raw humus had a maximum of 19,000 animals per square meter and spruce raw humus 12,000, as compared with 3,000 to 6,000 for mulls.

Bornebusch (1930) estimated the oxygen consumption of the various groups of organisms he studied in the humus. The limitations of his estimates for use in comparing the roles of different organisms have already been discussed in Section V, F. He also made a provisional estimate of the amount of humus decomposed by animals in the following way: the annual leaf fall in beech and spruce forests amounts to about 400 grams per square meter; in oak and pine the fall is somewhat less. In complete combustion of humus, about the same weight of oxygen is consumed as organic matter decomposed. The total annual oxygen consumption of the fauna amounts to about a third to a quarter of the amount of oxygen required for the complete combustion of the annual leaf fall. Bornebusch thence concluded that the fauna accounts for the decomposition of from one-fifth to one-quarter of the annual leaf fall. In so far as Bornebusch's respiratory estimates are underestimated (see V, F), this figure is an underestimate.

TABLE 7

Weight of Fauna of Spruce Raw Humus and Oak-Mercurialis Mull in Denmark, to a Depth of 5 cm.

Adapted from Table 18, Bornebusch (1930) and the table on page 108, Overgaard (1949).

	SPRUCE RAW HUMUS (g. per sq.m.)	OAK-MERCURIALIS MULL (g. per sq.m.)
Decomposers (dominantly)		
Oligochaetes	1.55	61.68
Diplopoda	—	4.70
Acarina	4.49	0.60
Collembola	6.85	5.00
Diptera	1.03	3.10
Coleoptera	3.14	0.18
Other insects	1.12	0.55
Nematodes	4.50	—
Total	22.68	75.81
Predators		
Coleoptera	0.53	0.17
Araneida	0.07	0.06
Chilopoda	1.76	0.61
Total	2.36	0.84

On the other hand, it is not known whether all the organisms included as "decomposers" actually derive all their energy from the plant litter. To the extent to which further nutrition studies may indicate that these animals feed on other tissues, Bornebusch's estimate for the role of the fauna will be an overestimate. Despite its limitations, Bornebusch's study is invaluable in pointing to the possibilities of studying the soil and plant litter community in terms of energy utilization.

The soil fauna may play a minor role in direct decomposition of plant litter by comparison with the microflora; but it probably has a significant role in making organic matter more readily available to the microflora through the subdivision of the plant litter and its incorporation into the soil. The predatory organisms play a direct part in determining the level of the population density of the decomposer organisms, particularly the microflora.

VII. SUMMARY

1. A basis is presented for the study of organisms associated with decomposition of plant litter in forest soils. These can be studied as a community in which the first trophic level is plant litter.

2. In lieu of a "food-web" the organisms found in forest soils are grouped broadly, on the basis of feeding habits, into four main categories: plant litter feeders, fungal feeders, bacterial and algal feeders, and micro- and macro-predators. The feeding habits and behavior of animals in these various groups are reviewed. The plant litter feeders include the oligochaetes, myriapods, crustacea such as the isopod *Trichoniscus* and the amphipod *Talitrus*, ants, termites, and various other arthropods. Less is known about fungal feeders, though collembola appear to be important animals in this category. Bacterial feeders include protozoa, myxobacteria, and nematodes. Many of these are selective feeders on bacteria. The feeding relationships are so complex that no simple relationship between the numbers of protozoa and bacteria can be expected. The role of larger predators of soil organisms is less well known.

3. A characteristic feature of the soil fauna is the tremendous diversity of species. This is attributed (a) to the diversity of the different sorts of spaces in the soil, some of which are air spaces and others water films of different sizes, (b) to the heterogeneity of the solid constituents of the soil and (c) to the diurnal and seasonal changes in temperature and moisture in the soil.

4. A procedure is suggested for the study of the role of different organisms in soil on the basis of the amount of energy which "flows" through them during a year. This approach is parallel to the limnological studies of Thieneman (1918) and Lindeman (1942). Information of this sort which is available for soil fauna has been summarized from the works of Bornebusch (1930) and Overgaard (1949). Tables are given of the numbers of organisms in different soils and the energy utilization of such of these as have been studied.

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GENERAL BIOLOGY: PHILOSOPHY AND EDUCATION

ASPECTS OF FORM. *A Symposium on Form in Nature and Art.*

Edited by Lancelot Law Whyte. Pellegrini & Cudahy, New York. $6.00. x + 249 pp.; ill. 1951.

As one proceeds through the pages of this book one is likely to experience, in quick succession, a wide variety of sensations extending from boredom to fascination, from the frustration of confusion to the pleasure of clarity. It suffers, I suppose, from the disease of all collections of miscellaneous essays which are held together solely by the firmness of the threads of the binding, yet nevertheless there are enough really excellent articles in this book to make it more than worth while. The fundamental obstacle to making such a book a cohesive unit is the subject, for "form," as the book amply illustrates, has so many meanings and significances that it becomes hard to imagine any specific topic that would not in some way apply. The relation, therefore, of the particular essays is often about as close as the successive articles in the *Encyclopedia Brittanica*, despite the valiant efforts of the editor, L. L. Whyte, to weave them together in his Introduction, and in his Chronological Survey on Form at the end of the volume.

The first chapter is that of a crystallographer, S. P. F. Humphreys-Owen, and it is a lucid, interesting, and most instructive discussion of the form of matter: of atoms, molecules, gases, liquids, and mostly of crystals and their growth. Next comes a less satisfactory essay by an astronomer, C. C. L. Gregory, which seems like its subject to wander about in space and time. C. H. Waddington the embryologist has produced a most curious short essay called The Character of Biological Form, in which he presents the thesis that the form of a living organism is distinct from all other forms because it has an integrated wholeness. This "biological" quality is in part lost in the case of abnormal, deformed mutants, but it is a quality that is emerging in modern abstract sculpture. Much as I admire Picasso and Henry Moore, as well as Waddington's embryology, I do not think this essay is either profound or happy.

The next chapter is a beautiful, clear presentation of form in plants, by F. G. Gregory. In its pages there is a wealth of material with interesting insights into problems ranging from studies on plant hormones to the spirals of leaf whorls. The biochemical aspects of form are covered by the chemical embryologist Joseph Needham in a fine essay which begins with a penetrating critique of D'Arcy Thompson and ends with a mature

consideration of the problem of the rapprochement between biochemistry and morphology. Another embryologist, A. M. Dalcq, has a long essay which is difficult to read and will be especially so for those who are not embryologists. There are, however, rewards for the labor in the strictly biological part, although Dalcq's position is highly partisan, and his opinions concerning the inadequacy of the present evolutionary theory as well as those concerning the relation of embryonic induction to psychic phenomena are likely to disappear into the chasm between the philosopher and the empirical scientist.

The next chapter is a pleasant and refreshing interlude, full of mental and actual pictures of the external forms of animals, especially in relation to patterns of coloration, protective shapes, and mimicry. It is written by H. B. Cott and follows some of the thoughts in his excellent book on the same subject.

Three successive chapters relate to psychology. The first, by K. F. Lorenz, on gestalt perception is perhaps the most brilliant and the most interesting essay in the whole book. W. G. Walter follows with an unsatisfactory discussion of brain waves, but it might possibly be that the difficulty lies not in the article but in the fact that so little is known of the significance of brain waves. Another psychologist, R. Arnheim, has a rather slow and difficult article on aesthetic perception.

The last essay in the book is written by an art historian, E. H. Gombrich. It is an urbane and well phrased analysis of the problem of representation in art, and it does, in many ways, provide a satisfactory ending to the book. It brings home the point, one suggested at many places in the book, that our aesthetic appreciation of form is something that neither the scientist nor the humanist can ignore, and this subject does provide a useful meeting ground. There is no doubt that this meeting is important and that *Aspects of Form* contributes to it, even though it does so in its own special patchwork way.

JOHN TYLER BONNER

MAN IS A MICROCOSM.

By J. A. V. Butler. The Macmillan Company, New York. $3.00. x + 162 pp. 1951.

J. A. V. Butler presents a short, excellent, résumé of the current status of research with respect to the nature of life. The question actually revolves around the consideration of the possibility of the construction of a living organism in the laboratory. The mere statement that Butler comes forth with a resounding "No" as the answer, for any foreseeable future, does not give due credit to the logic of his exposition. In enumerating the enormous difficulties to be surmounted in the construction of even the simplest cell, much illumination is cast on our present knowledge of the subject.

When Butler considers, however, certain of the problems of the more complicated organisms, his authority is somewhat diminished. He is impressed, as most biologists are, by the fact that in a universe of increasing entropy life seems to run counter to that principle in the organization of its own energy. His conclusion, like Kelvin's, is that the principle holds "on the whole," but that a living organism demonstrates an ability to direct its own organization. In this, he seems to be in complete accord with Aristotle's teleological interpretation.

Being duly impressed by the working of the brain, the author attempts to come to grips with the problem of "free will." He states the classical position of LaPlace, that given the parameters p and q, of position and momentum, respectively, it is possible to predict their values at any moment of time. Such strict causal determinism, (though the book seems to be written in that spirit), is then countered by a reference to the uncertainty relations of Heisenberg. In this, Butler sees the possibility that a complex organism may choose its own behavior. He at no time states how this analogy might hold; and indeed I do not believe he could. Finally, he surrenders the problem, leaving it suspended on the grounds of its complexities.

MARK BLANK

PSYCHOLOGY AND PHILOSOPHY OF TRUTH.

By Frederick E. Eastburg. Bruce Humphries, Boston. $2.50. 78 pp. 1947.

Frederick E. Eastburg brings a strong religious orientation to philosophy and science. In his sympathy with the beauty of religion, and its transcendent quality, he fails to do justice to either philosophy or science. To consider only the latter aspects, he understands science as materialistic, grossly mistaken in the notion that it is dealing with observables only. The limitations of science follow from its alleged epistemological weakness, i.e., its unwillingness to accept the "higher value" of a transcendent reference, essentially mystical. He completely fails to appreciate that a sober scientist attempts to delineate the area in which his method is operable and his propositions meaningful. Eastburg is consequently attacking straw men of his own construction, and at times none too successfully.

MARK BLANK

PHILOSOPHIES IN BRIEF.

By Frederick E. Eastburg. Bruce Humphries, Boston. $2.50. 78 pp. 1948.

Philosophies in Brief consists, first, of reminiscences of the author's personal excursions into philosophy; and, secondly, discussion of some of the important schools of thought, such as rationalism, empiricism, idealism, etc.

The expositions of these systems are too short to be of any value to someone seeking acquaintance with their basic concepts, and useless to anyone who already knows them. According to the author, such knowledge is unnecessary for anyone with an abiding religious faith, anyhow.

MARK BLANK

PRINCIPLES OF MODERN BIOLOGY. *A Complete Reconstruction and Modernization of Charles R. Plunkett's Elements of Modern Biology. Revised Edition.*

By Douglas Marsland. Henry Holt & Co., New York. $5.25. xvi + 757 pp.; ill. 1951.

This second edition of Marsland's modernization of Charles R. Plunkett's *Elements of Modern Biology*. which first appeared in 1945 (*Q. R. B.*, 20: 373. 1945), has incorporated a considerable amount of new material, added a new chapter on ecology, more than 50 new drawings, and has improved the printing of the many excellent photographs, with an actual reduction in total pages. The result is a clearly written and admirably integrated introductory survey of biology. The sections on the cell and heredity and evolution are very satisfactory, and in general the emphasis is functional. Covering as it does, in highly condensed fashion, the whole of knowledge regarding plants and animals, it sometimes seems to mention too many details in too cursory a fashion. In the section on multicellular animals there are several asides of doubtful validity, such as the implication that the administration of 10 per cent CO_2 is effective in initiating the respiration of newborn infants. However, my chief criticism arises from my feeling that many students, exposed to this book in their formative years, will be unable to resist the temptation to become professional biologists, to such an extent that perplexing ecological imbalance may result.

EVELYN HOWARD

NEW BIOLOGY 11.

Edited by M. L. Johnson and Michael Abercrombie. Penguin Books, Harmondsworth, Middlesex; [Baltimore, Md.]. 50 cents. 123 pp. + 16 pl. 1951.

Contents: Editorial; Problems of Adaptation (P. B. Medawar); The Mechanism of Photosynthesis (G. E. Fogg); Aphids and Plant Growth (J. S. Kennedy); The Banana (C. W. Wardlaw); Accident Proneness (R. C. MacKeith); Some Features of the Biological Activity of Molecules (H. O. J. Collier); Famous Animals 4—*Paramecium* (C. H. Brock).

BIOLOGIA. *An International Year-Book Devoted to the Pure and Applied Plant and Animal Sciences. Vol. 2 (1950/51). Chronica Botanica, Vol. 12, Nos. 4/6. Edited by the Editors of Chronica Botanica, Frans Verdoorn, Managing Editor. Chronica Botanica Company, Waltham, Mass.* $4.75 (paper). Pp. 117–331 + 2 pl.; text ill. 1951.

Like all the Chronica Botanica publications, this yearbook is beautifully printed and illustrated, and is a credit to the indefatigable labors of the editor Frans Verdoorn. The contributions in one respect completely belie the title of the yearbook, for they are practically without exception from the *botanical* sciences. Many of the articles are of interest to the student of the history of the biological sciences, and not a few to those who are concerned with the organization of the sciences and the problems of international cooperation and of publication. A section of book reviews is included; and the volume ends with a special supplement by H. J. Phaff, on Fruit and Vegetable Dehydration, Principles and Advances (1864–1945). This yearbook forms the second half of Vol. 12 of *Chronica Botanica*.

BENTLEY GLASS

BULLETIN OF THE STATE INSTITUTE OF MARINE AND TROPICAL MEDICINE IN GDAŃSK, POLAND. *Vol. II, Nos. 3–4; Vol. III, Nos. 1–2.*

The Institute of Marine and Tropical Medicine, Gdańsk, Poland.

I, No. 1: Pp. 1–65. 1948.

II, Nos. 1–2: Pp. 1–120. 1949.

II, Nos. 3–4: Pp. 121–278 + 2 folders. 1949.

III, Nos. 1–2: Pp. 1–129. 1950.

These Bulletins are prepared in English (and excellent English at that) so as to provide quite lengthy summaries of original papers appearing currently in Polish scientific periodicals. The subjects range over the fields of bacteriology, physiology, epidemiology, pathology, endocrinology, immunology, parasitology, and include even some climatology (comparisons of the climate of Poland and the United States; Climatic Features of Florida, a Sunny Subtropical Land).

This peek at science behind the Iron Curtain, nicely served up to those who can read no Russian or Polish, is as interesting as it is surprising. These Bulletins deserve to be widely distributed.

BENTLEY GLASS

ON GROWTH AND FORM. *Vols. I and II. Second Edition, reprinted.*

By D'Arcy Wentworth Thompson. Cambridge University Press, New York. $15.00. vi + 1116 pp. + 1 pl.; text ill. 1952.

The tremendous advantage of having this monumental classic of biology divided into two still good-sized volumes, sturdily bound, will be gratefully acknowledged by every reader. May there be many!

BIOLOGY: HISTORY AND BIOGRAPHY

FRANCIS BACON—*Philosopher of Industrial Science.*

By Benjamin Farrington. Henry Schuman, New York. $3.50. xvi + 202 pp. + 6 pl. 1949.

This volume is one of a series entitled the Life of Science Library—a series devoted to the history of science. No such library would be complete—or even well begun—without some analysis and study of the life and works of Francis of Verulam. Bacon, in a sense, was a one-man Renaissance. He was, moreover, part of a historical revolt against the rationalism of thought of the Middle Ages—that is, against the belief that truth could only be reached through metaphysical analyses of the nature of things. In science, this revolt meant the rise of experimentation and the inductive method of reasoning. This was a time of great intellectual unrest—and great genius—the century of Cervantes, Harvey, Kepler, Galileo, Bruno, and a little later, Newton, Descartes, Boyle, Spinoza, Leibniz, and others.

Among these pioneers, it fell to Bacon to pave the way in the sphere of pure laws of thought. From his earliest years he planned to reform all human knowledge. The present volume begins by pointing out his lifetime devotion to a great idea, namely "... that knowledge ought to bear fruit in works, that science ought to be applicable to industry, that men ought to organize themselves as a sacred duty to improve and transform the conditions of life." Unceasingly, Bacon fought for understanding of "the revolutionary possibilities of man's increasing control over natural forces."

Many biographers, philosophers, and others have devoted themselves to studies of Bacon's life and works, but Farrington has filled a gap with his simple, clear and objective assessment of the man, primarily as a philosopher of industrial science—perhaps, we might say, as the earliest of the technocrats. He is considered, in the words of the author, as one of the tiny minority which makes books out of life, not the majority which makes books out of books. He fought for the fate of mankind, a battle which involved castigation and denial of the intellectual pillars of the day—Aristotelianism, the scholasticism and monasticism of the Middle Ages, and the absence of awareness of an interest in facts. Whitehead has pointed out that he had the most direct apprehension of the full extent of the intellectual revolution which was in progress. (It is amusing to consider that he was anticipated nearly a century earlier by Leonardo da Vinci, whom some have considered even more "a man of science" than Bacon. "At the beginning of the modern period da Vinci and Bacon stand together as illustrating the various strains which have combined to form the modern world, namely, legal mentality and the patient observational habits of the naturalistic artists.") To be sure, although Bacon was one of the great pioneers in natural and social scientific thought, his philosophy, as Farrington states, was full of contradictions. Three of these contradictions are discussed, namely: a) his division between divine and natural knowledge; b) his contradictory view of the human soul; and c) his contradictory view of the history of science. However, despite these and other faults (his unawareness of the real complexity of the inductive method, for example), Bacon's writings still remain vital, stimulating, and great human documents. One wonders how he would view mankind today—a mankind which has so largely followed his advice, but has so misused its treasures and successes.

Farrington has done a fine job of clarifying those Baconian intellectual drives and accomplishments which are not usually stressed by others. The publisher should also be congratulated for maintaining his usual high standard as regards the physical properties of the book. It is heartily recommended to all those not only interested in the history of science, but in the development of man.

ROBERT G. GRENELL

A SHORT HISTORY OF SCIENCE AND SCIENTIFIC THOUGHT, *with Readings from the Great Scientists from the Babylonians to Einstein.*

By F. Sherwood Taylor. W. W. Norton & Co., New York. $5.00. x + 368 pp. + 28 pl.; text ill. 1949.

This is the same book published in Great Britain under the title *Science Past and Present*, and previously reviewed (*Q. R. B.*, 22: 143. 1947). The American format is an improvement.

THE YOUNG NATURALIST

PLANET EARTH.

By Rose Wyler; illustrations by John Sand. Henry Schuman, New York. $2.50. iv + 156 pp.; ill. 1952.

This is a fascinating little book which might be called a "space-minded geography." Such chapter titles as

Where in the Heavens is the Earth, Our Planet Makes its Rounds, and Planet of Plenty give a good impression of the author's skill in writing about our planet in a way to interest children.

ELLA THEA SMITH

THE STRANGE STORY OF OUR EARTH. *A Panorama of the Growth of Our Planet as Revealed by the Sciences of Geology and Paleontology.*

By A. Hyatt Verrill, with an introduction by L. Don Leet. L. C. Page & Company, Boston. $3.75. xviii + 263 pp. + 16 pl.; text ill. 1952.

This popular account of the geology and paleontology of the earth makes interesting and often exciting reading. A. Hyatt Verrill, the son of a one-time assistant to Louis Agassiz, is an explorer and collector in archeological and ethnological fields. Professor L. Don Leet, Chairman of the Division of Geological Sciences at Harvard University, says in his Introduction to *The Strange Story of Earth:* The book "is a blend of information, colorful anecdote and imaginative speculation. . . ." It should interest the general reader and give him a glimpse of these two fields of science he can never forget.

ELLA THEA SMITH

WATER FOR PEOPLE.

By Sarah R. Riedman; illustrations by Bunji Tagawa. Henry Schuman, New York. $2.50. viii + 151 pp.; ill. 1952.

This book was written "for all children . . . who keep asking a hundred and one questions about water—where it comes from, where it goes—why it grows scarce, how we can get more—. . . ." The author has done a fine job in an interesting way.

ELLA THEA SMITH

THE CITY.

By Rod and Lisa Peattie; illustrated by Bunji Tagawa. Henry Schuman, New York. $2.50. iv + 108 pp.; ill. 1952.

This little book tells simply and interestingly the story of four cities, one ancient, and one medieval and two modern cities.

ELLA THEA SMITH

OUTDOOR ADVENTURES. *A Rediscovery of the Wonders of the Out-of-Doors.*

By Hal H. Harrison. Vanguard Press, New York. $2.75. 128 pp.; ill. 1951.

The author, in following his two children as they discover the many facets of nature about them, has provided an excellent written and pictorial history of what an awakened and an enlightened interest in the outdoors can yield in the way of pleasure and information to curious youngsters. The story covers a 2-year span, but is divided into sections covering the four seasons. A single adventure takes up a page, and is accompanied by 2 photographs on the opposite page which point up the text and instill life into what, to an unknowing youngster, might be just words. The fact that these are the adventures of a very real and wide-awake brother and his younger sister lends a personal touch to the volume which takes it out of the ordinary run of nature books, and commends it to children from 8 to 14 years of age. The visual and written subject matter are expertly blended and appropriately chosen.

C. P. SWANSON

ANIMALS FROM EVERYWHERE. *Revised Edition.*

By Clifford Webb. Frederick Warne & Co., London and New York. $2.00. 63 pp.; ill. 1950.

This is a very pleasant children's book about some common and uncommon animals. There are 29 full-page drawings, many in color, and each is accompanied by a page of text about the animal concerned. The drawings are executed with care and imagination; the text should be appropriate for second-graders. Squeals of delight from my twins when they leafed through this book are perhaps a better endorsement for it than anything I could say.

A. CHAPANIS

BILLY BASS.

By R. W. Eschmeyer. Fisherman Press, Oxford. 50 cents. 47 pp.; ill. 1951.

FREDDY FOX SQUIRREL.

By R. W. Eschmeyer. Fisherman Press, Oxford. 50 cents. 49 pp.; ill. 1952.

CHARLEY COTTONTAIL.

By R. W. Eschmeyer. Fisherman Press, Oxford. 50 cents. 50 pp.; ill. 1952.

BOBBY BLUEGILL.

By R. W. Eschmeyer. Fisherman Press, Oxford. 50 cents. 47 pp.; ill. 1952.

TOMMY TROUT.

By R. W. Eschmeyer. Fisherman Press, Oxford. 50 cents. 48 pp.; ill. 1952.

These books are about the adventures of wild animals and the human beings (farmers, sportsmen and con-

servation experts) with whom they come in contact. The animals are treated objectively, not anthropomorphically: indeed, there is considerable emphasis on the differences in mentality between man and beast. Nuggets of conservation theory are imbedded in the stories: in the adult view, they may even stick out from the surface, but the young will probably take them in their stride and not be deterred by them. The illustrations, in single tone, are very attractive.

Any of these books can be read to children 6 years old and up, or, of course, read to themselves by the older children.

EILEEN S. GERSH

BEGINNERS GUIDE TO ATTRACTING BIRDS.
By Leon A. Hausman; illustrated by Jackson Miles Abbott and the author. G. P. Putnam's Sons, New York. $2.00. 127 pp.; ill. 1951.

The home owner who would made his environs attractive to the birds of his neighborhood during periods of food scarcity and storm conditions will find many helpful suggestions in this book. The topics discussed include types of food, feeding stations of various sorts, storm shelters, nesting boxes, shrubs for food and for shelter, and drinking dishes. Most of the suggestions are those one would ordinarily think of anyway, but it is nice to have them together in a single volume. A key for easy bird identification, and a list of references on special topics adds to its value.

BIRDS AND THEIR NESTS.
By Olive L. Earle. William Morrow & Company, New York. $2.00. 64 pp.; ill. 1952.

Country boys in Britain, 30 years ago at least, engaged avidly in the reprehensible hobby of collecting birds' eggs, and I approached this book with the memories of an old passion. Hollow trees were to be raided with circumspection, because owls were notoriously fierce at nesting time; nightingales built in impenetrable thickets; the rookeries were tantalizingly conspicuous, but quite unapproachable in the tops of beeches and poplars. This volume, charmingly illustrated and with a readable text, uncluttered with sentiment, has many familiar, and some utterly exotic nests. I missed the beautiful domed moss nest of the wren, and the horsehair one of the tomtit, but the hanging creations of the orioles and orpendolas, and the apartment house of the weavers compensated. Surely the weird mud chimneys of the flamingoes must have suggested to their cousins the European storks that real chimney pots were an admirable substitute, when suitably roofed over. Since birds in their nest building are nothing if not adaptable, I have wondered if cellophane has not by now been incorporated into their scheme of things. This is a fine book for adults to read to children, and children should like it, too.

H. R. CATCHPOLE

SPIKE. *The Story of a Whitetail Deer.*
Written and Illustrated by Robert M. McClung. Wm. Morrow & Company, New York. $2.00. 64 pp.; ill. 1952.

This well-written book, illustrated with dainty reproductions in black and white, is well suited for children 6 to 8 years of age. Covering much of the same ground despoiled by Bambi and his inhuman animals, the book avoids the insipidly anthropomorphic attitude and retains a great measure of natural behavior. Yet it has its moments of danger and excitement to enthrall children, and also of tender peace.

ISIDORE GERSH

BASIC SCIENCE. *A Textbook in General Science.*
By J. Darrell Barnard and Lon Edwards. Macmillan Co., New York. $3.40. viii + 631 pp. + 12 pl.; text ill. 1951.

This is a general science textbook for junior high schools. The authors state that they wrote the book to show students how to use science to improve everyday living. The book is organized around 13 units, each representing "a major area of adjustment and adaptation." "All principles and generalizations recommended . . . throughout the country are included," with more space given to biology than is usual in general science textbooks, so the publishers state. A special effort is made to give students insight into and practice in the use of "the scientific methods." Many experiments, demonstrations, and other student activities have been included. More than 450 illustrations and 7 attractive but not particularly useful color plates add to the book's appeal. For the most part, the illustrations are well chosen and easily understood.

As usual with first editions, *Basic Science* contains some inaccuracies, e.g., "Mendel self-pollinated hybrid peas"; and, "fluids from the blood entered the wounded region and formed a thick pus." There seems to be a rather heavy load of terminology, but each new term is carefully defined and italicized at its first appearance. *Basic Science* should appeal to those teachers who are especially interested in teaching principles and generalizations that may help the student in his daily living.

ELLA THEA SMITH

MODERN SCIENCE. *Book III.*

By H. Webb and M. A. Grigg. Cambridge University Press, London and New York. $1.00. viii + 188 pp.; ill. 1951.

This elementary science textbook covers some astronomy, magnets, electricity, and some biology. It abounds in simple, interesting experiments and investigations, and aims through them to help the student gain practice in working the way scientists do—certainly a more effective method than merely discussing "scientific methods."

ELLA THEA SMITH

THE YOUNG SCIENTIST. *Activities for Junior High School Students.*

By Mailland P. Simmons. Exposition Press, New York. $3.00. xii + 164 pp.; ill. 1951.

This book is exactly what its name implies: a book of science activities for the junior high school level. The activities are clearly explained, and line drawings help to show how they are to be done. An abundance of thought-provoking questions should arouse curiosity and lead to interpretations of results.

ELLA THEA SMITH

ECOLOGY AND NATURAL HISTORY

THE CLIMATE NEAR THE GROUND.

By Rudolf Geiger; a translation by Milroy N. Stewart and others of the Second German Edition of Das Klima der bodennähen Luftschicht, with revisions and enlargements by the author. Harvard University Press, Cambridge, Mass. $5.00. xxii + 482 pp.; ill. 1950.

The Climate Near the Ground is a translation of a German textbook of microclimatology by one of the world's foremost climatologists, Rudolf Geiger. In an earlier edition in 1927, Geiger, a professor of meteorology at the University of Munich, defined the science of microclimatology and systematically studied the problems involved. John Leighly translated that edition for the official use of the Soil Conservation Service of the Department of Agriculture under the more literal title, "The climate of the layer of air near the ground." At Leighly's suggestion, a copy of the second edition of Geiger's book was obtained in Germany after the war by the Air Force Weather Service. By the time the translation of the second edition was almost completed, contact had been made with Geiger and the existence of a third edition was discovered. The present work is a translation of the second edition, brought up to date with additions from the unpublished later edition by Geiger himself, who spent the summer of 1950 in the United States lecturing at the Johns Hopkins Laboratory of Climatology.

The major part of the translation is the work of Milroy N. Stewart of the Rochester, New York, branch of the American Meteorological Society, with certain chapters checked by F. A. Brooks of the University of California, and others. Special funds provided by Harvard University made possible the publication of the book by the Harvard University Press.

In his Introduction, the author states that microclimatology has been developed in Germany because the lack of living space makes necessary the maximum use of the earth's resources. He points out that the book has the same purpose as the earlier *Climate Near the Ground*, but the new edition contains references to some thousand or more new works published since 1927. Geiger defines microclimatology as the climate of the layer of air between the surface of the earth and two meters above it, thus differentiating it from the climate in which man lives, which he terms the macroclimate.

The book is divided into two parts. Part I deals with the physics of the layer of air near the ground, or, as the author states, the "microclimate existing near the ground by virtue of its proximity to the ground surface." The second part of the book concerns the microclimate in its relation to topography, and to plants, animals, and man.

In the first section, the author thoroughly and logically explains the various forms of heat exchange that are important in a study of the microclimate. He gives the results of all the research available to him in the fields of radiation, conduction, and turbulence in the lowest air layers. The reader will be amazed at the amount of data published, most of it in German, on the temperature distribution in the air near the ground. The author draws attention to the technical difficulties in measuring accurately the small differences in temperature necessary for an understanding of the temperature relationships. Electric thermometers artificially shielded and ventilated, or resistance thermometers of such small diameter that the radiation errors can be neglected, were used most frequently in German research. The types of thermocouples and shields used are not described, but the author realized the importance of thermometer shielding where very small differences in temperature are being measured. At the Johns Hopkins University Laboratory of Climatology, it has been found that the whole problem of investigating the temperature relationships near the ground boils down to the problem of instrumentation, to the study of thermocouple and shield design (see The Johns Hopkins Univ. Lab. Climat., Interim Rep. #5, 2 pp.).

In the chapter on the measurement of humidity, the author again admits the difficulties in adapting the technique of humidity measurement to the needs of climatology. The instruments used most frequently in the studies quoted by Geiger were the hair hygrometer

and the thermocouple psychrometer, which he describes as equally faulty. He mentions that the most promising method of making microhumidity measurements is one using dilute sulphuric acid, but adds that unfortunately no results are available from the use of this instrument. In the chapter on wind, Geiger states that the problem is one of measuring very low wind speeds, and that the hot wire anemometer gives accurate, direct measurements of the lowest wind speeds; again no readings are available using this type of instrument.

The author next discusses the influence of various types of soil on the climate of the boundary layer of air; then the influence of water and snow on the air layers above them. The effect of living ground cover such as sod or small seedlings is included in this section only because they alter the nature of the ground surface.

Part II, dealing with the microclimate in its relation to topography, plants, animals, and man, is a masterpiece of German thoroughness. The influence of different slopes, ridges, valleys, and even glaciers on the microclimate is carefully studied. One chapter is devoted to the sunniness of various slopes. Geiger himself carried out an interesting investigation of the "skin of air" on the slopes of an isolated mountain cone in Bavaria. The succeeding chapter contains an account of another study conducted by Geiger and others of the microclimate of valley floors, slopes, and ridge crests. A chapter entitled The Range of Validity of Meteorological Stations opens a question in which the author, as director of the Meteorological Institute, is especially interested. Here it is pointed out that there can never be a sufficient number of meteorological stations to give a picture of all the variations in climate, even in a country as small as Germany, but that by studying the microclimate at one place, it is possible to draw conclusions about the meteorological conditions at neighboring locations. The microclimate of caves is considered in a supplementary chapter.

In a discussion of the influence of plant cover on the microclimate, the author first discusses the heat economy of plants, and plant temperatures, and states that the measurement of the temperatures in a plant cover is no easy task. The next 2 chapters deal specifically with the microclimate of agricultural crops. The results of a lysimeter experiment are given to show that the evaporation from vegetation is twice that from bare soil, and one German scientist is quoted as saying that certain vegetative covers may increase the evaporation 5-fold. Neither of these statements agrees with recent findings on this continent. Results from an experiment to measure potential evapotranspiration at the Johns Hopkins Laboratory of Climatology have indicated that crops as different as spinach and corn had similar water losses with similar weather conditions (see The Johns Hopkins Lab. Climat., Interim Rep. #7, 32 pp.). In a Toronto experiment, it was found that the evaporation from bare soil was about 75 per cent of that from sod (Sanderson, M. Three Years of Evapotranspiration at Toronto. *Can. J. Res.*, 28, C: 489).

Seven chapters are devoted to the study of forest meteorology. Geiger is an authority in this field and has directed two large-scale field investigations of forest climates in Bavaria. He discusses the old question of the influence of reforestation on precipitation, and quotes one German scientist as saying that precipitation was increased 6 per cent by reforesting, while in the Congo region in Africa, precipitation was said to be 30 per cent greater in the forest than in the cleared areas. Geiger seems skeptical about these statements, and states that the problem must be tackled in more detail by comparing the entire heat and water balance in reforested and unplanted ground. The next chapters consider every aspect of the climate in and near old stands, clearings, and forest borders. These 7 chapters comprise the best treatise on forest climatology in the English language, and should prove invaluable to foresters in this country.

The last section concerns the relation of animate creatures and man to the microclimate. Entomologists especially will be interested in the author's statement that insects are the very best of climatic indicators. The section on the effect of man on the microclimate includes a study of city climates and the climate within buildings. Geiger points out that while man cannot change the macroclimate, he can mold the microclimate to his will. For his personal comfort, he can change his dress and the type of shelter in which he lives. He can change the climate for his domestic animals by building barns and shelters, and he can deprive harmful insects of their favorable climate. He can change the microclimate of his plants by growing them in greenhouses and by protecting those grown in the open against wind and frost. The last 2 chapters in the book deal with destructive frost and the battle against it. Much less space is devoted to this problem than in the earlier edition. Instead, the reader is referred to a recent, comprehensive publication (in German) entitled *Protection against Frost Damage*.

The list of references which the author provides at the end of the book will be of great interest to scientists in many allied fields. The references number 821, but unfortunately, only 129 are in English. It is to be hoped that the bulk of these microclimatic studies, the work of German scientists, will be made available to students in this country. The sources of the 181 illustrations are also listed, and an index of authors and subjects is supplied.

Little criticism can be made of the translation itself. The English is clear and idiomatic, and there are few sentences of the lengthy, involved type so common in German scientific works. All English-speaking scientists are much indebted to Stewart and those who collabo-

rated with him in the translation of Rudolf Geiger's work.

The Climate near the Ground provides an excellent and much-needed textbook of microclimatology for the use of the foresters, agriculturists, and entomologists, as well as for climatologists. It supplies a comprehensive study of the German and European research in microclimatic and allied fields, and the detailed bibliography clearly outlines the source materials.

Further advancement in the science of microclimatology must await the perfection of instruments necessary for making accurate measurements. Only when measurements with precise instruments have been made, can the laws governing the microclimate be completely understood.

MARIE SANDERSON

PUBLICATIONS OF THE INSTITUTE OF MARINE SCIENCE. *Vol. I, No. 2.*

University of Texas, Printing Division, Austin. $1.50 (paper). 194 pp. + 6 folding figures; text ill. November, 1950.

Volume I, Number 1 of this serial publication having appeared in 1945, the present issue is virtually a rebirth. The well-printed issue is profusely illustrated with excellent graphs and diagrams, but the few plates of half-tones have not come out too well. The contents of this issue are as follows: Seasonal Population Changes and Distributions as Related to Salinity, of Certain Invertebrates of the Texas Coast, Including the Commercial Shrimp (Gordon Gunter); The Invertebrate Fauna of Texas Coast Jetties; a Preliminary Survey (H. L. Whitten, H. F. Rosene, and J. W. Hedgpeth); Distributions and Abundance of Fishes on the Aransas National Wildlife Refuge, with Life History Notes (Gordon Gunter); Notes on the Marine Invertebrate Fauna of Salt Flat Areas in the Aransas National Wildlife Refuge, Texas (Joel W. Hedgpeth); An Introduction to the Hydrography of Tidal Waters of Texas (Albert Collier and Joel W. Hedgpeth).

WATER, LAND, AND PEOPLE.

By Bernard Frank and Anthony Netboy. Alfred A. Knopf, New York. $4.00. xviii + 331 pp. + xi pp. + 24 pl. 1950.

WATER—OR YOUR LIFE.

By Arthur H. Carhart; foreword by Jay N. Darling. J. B. Lippincott Co., Philadelphia and New York. $3.50. 312 pp. 1951.

The greatest menance to the national security of the United States is not the threat of global war, but the depletion of natural resources, and the most important of these is water. That the water supply is being exhausted more rapidly than it can be replenished by nature is universally recognized. Lake Tulare, navigated by steam power a century ago, is dry now; the water table at Baltimore has dropped 150 feet within historic times; the deciduous forests which covered Arizona during the ascendency of the Cochise culture have disappeared; the pollution of the Schuylkill by the culm discharged from the coal mines is well known, though in this case the state has undertaken a program of reclamation under which this river is slowly recovering its purity.

This depletion of water resources is largely the result of cosmic processes which for the present seem beyond our control. The Pleistocene lakes in the Great Basin were among the world's greatest; today they are represented by insignificant relicts. The Tigris and Euphrates valleys supported a population of 40 million in Biblical times; today Mesopotamia is mostly desert. The snow line on Popocatepetl has been receding at a measurable rate since the conquest; the Sahara desert is advancing one kilometer every year; the intake of the Grand Canal in China is now 50 feet above water level in the river; and the edge of the continental ice sheet, which came as far south as the Ohio River some 20,000 years ago, is now confined largely to Siberia and Greenland.

All of this water is now in the ocean, where it is not available for either irrigation or water power. And the process is still going on, making the need for an intelligently planned program of water utilization and conservation indispensable. Yet instead, we find the uncontrolled use of water per capita increasing annually. The human body requires from 6 to 8 pints of water each day to replace what is lost through processes of metabolism. But bathing, laundering, and dishwashing, etc., raise the need to over 100 gallons a day. It takes 6 gallons to flush a toilet and such devices as spindryers, air conditioners, and garbage disposers more than double this amount needed for personal use.

If the water used for commercial purposes be apportioned against the individual, the personal allotment is increased to 1300 gallons a day. It takes 7 to 10 gallons to process 1 gallon of gasoline; 128 gallons to process 1 gallon of alcohol; 65,000 gallons for 1 ton of steel; 200,000 for a ton of rayon; 300,000 for a ton of magnesium; 600,000 for a ton of rubber; and 1¼ million gallons for 1 one ton of bromine. Most of this water is used for cooling machinery; it is evaporated into steam and discharged into the atmosphere. It is true that one Ohio factory has installed condensers, but the water so salvaged raises the temperature of the river into which it is discharged, to the serious detriment of fish and other wild life.

Commercial water may be used in four ways—for industry, for agriculture, for transportation, and for recreation. The two latter uses do not consume the

water which they use, but the two former do so, and seriously impair the supply for all four purposes. Water used commercially frequently cannot be used again, either because it has been consumed, or because it has been polluted. Utah Lake formerly served as a source of supply for the irrigation of the Great Salt Lake Valley, but the discharge into it of waste matter from the steel plant at Geneva has contaminated it so that it is no longer fit for this purpose.

One of the chief sources of pollution, of course, is the discharge of sewage. Milwaukee discharges its untreated sewage into Lake Michigan, and replenishes the supply in its water mains from the same body of water after a suitable process of chlorination. But it would be cheaper as well as more sanitary to process the sewage first. Pittsburgh, Wheeling, and Cincinnati make an open sewer of the Ohio River. The taxpayers of these cities are saved the cost of treating the sewage, but this gain is more than offset by the cost of purifying the water used by the taxpayers of Louisville.

Two other factors entering into the wastage of water should be mentioned here. Along the coast of Texas lies a natural artesian basin where formerly a practically unlimited supply of usable water could be obtained by sinking wells. The abundance and cheapness of the water contributed to induce commercial enterprises to move in, and these were welcomed by local chambers of commerce. Had the new industries been satisfied with the natural artesian flow no harm would have been done, but they preferred to pump the wells, and because they withdrew the water faster than nature could restore it, the water table dropped. Water entering the basin comes partly from the mountains, and partly from the Gulf of Mexico. That from the latter source, being saline and therefore heavier, lies beneath the mountain water. But since the commercial enterprises have drawn off the surface water, that which is now available is too saline for domestic, agricultural, or industrial consumption.

The other factor is the overgrazing of the water sheds of Arizona by the cattle industry. With the cover crop removed, the hillsides can no longer retain their fertile topsoils. Observations of two contiguous valleys in California have shown that where the cover crop was retained the run-off was less than 0.5 per cent of the precipitation, but that where the land had been denuded the run-off amounted to over 60 per cent. It is true that in this case the denudation was due not to overgrazing but to fire; the results, however, are the same. Deprived of its covering protection the land erodes rapidly, losing its fertility, while the topsoil is deposited in the reservoirs, to reduce their storage capacity. The grazing lands of Arizona, like the artesian wells of Texas, have become a victim of greed.

The authors of these two books are in complete agreement as to the diagnosis, but fail to agree as to the remedy. The chief obstacle in the way of adoption of a sane water development policy lies in the great multiplicity of governmental agencies having partial jurisdiction over water. State boundaries have been drawn with no consideration of natural divides. Only 7 of the 48 states are bounded by divides, and in each of these cases the divide constitutes but a small part of the total boundary length. Furthermore, since each state may have different laws governing its water usage, it follows that a river may be subject to many different law codes along its course. California and Arizona are perpetually quarrelling over the Colorado River because neither gets enough water, and Arkansas and Mississippi quarrel over the Mississippi because each gets too much in time of flood. Besides this, the Federal Government has two fingers in the pie—one that of the Bureau of Reclamation, the other than of the Army Engineer Corps, both of which spend a large proportion of their appropriation to defeat the plans of the other. In addition, a dozen or so lesser agencies of the Federal Government have partial jurisdiction over water usage, and no attempt is made to coordinate their activities.

It has been suggested that a central water authority might be set up to supervise water planning on a national scale. The cattle grazers of Arizona have introduced a bill into Congress for a similar purpose. The Central Arizona Project, as envisaged by them, would make it mandatory upon the other 47 states to finance by public taxation a fantastic water development scheme to pull their chestnuts out of the fire. Under this plan New Jersey would be called upon to spend 68 million dollars in Arizona, Pennsylvania 158 million, and other states in proportion, for the benefit of less than 500 land monopolists whose avarice has brought about the situation in which they find themselves. These funds would be administered by a bureaucracy in Washington, and this would imply a thoroughgoing revolution in our way of life. In view of what has happened and is happening in those European nations where totalitarianism has been tried, one author feels that this would be too high a price to pay for security; the other seems to feel that revolution is inevitable anyhow, and that one might as well get used to it. While you and I hesitate between these two opinions, one of our most precious physical heritages is disappearing.

JAMES ISHAM'S OBSERVATIONS ON HUDSON'S BAY, 1743, *and Notes and Observations on a Book Entitled A Voyage to Hudsons Bay in the Dobbs Galley, 1749. The Publications of The Hudson's Bay Record Society.*

Edited with an Introduction by E. E. Rich; assisted by A. M. Johnson; Foreword by the Chairman. Published by The Champlain Society for The Hudson's Bay Record Society, London. Obtainable by sub-

scription to *The Publications of The Hudson's Bay Record Society*, $10.00 annually (Univ. Toronto Library). cvi + 352 pp. + x [List of Members and Subscribing Societies]. 1949.

James Isham, ca. 1716 to 1770, served the Hudson's Bay Company as book-keeper in the York Factory post, and as Chief Factor at Churchill River. Ill health in the 1742–43 trading season confined him to the fort, where he relieved boredom by writing his observations. "I have in cold Days and Long winter Nights, amusd. my self with the following Observations," which provide a vocabulary of local Indian language and sundry notes on their activities in the region. Many of these are helpful to the ethnologist in reconstructing a picture of Indian customs before white men had influenced them greatly. Isham describes at some length 7 kinds of geese, 3 of pheasants, a gray pelican, and various other birds. His comments on mammals include detailed notes on the method of capture. An assortment of plants with edible berries or roots is described.

Also included in the present book are "Notes and Observations on a Book entitled *A Voyage to Hudsons Bay in the Dobbs Galley &c 1746 & 1747* wrote by Henry Eliss's"—in which Isham attempts to correct a number of glaring errors. Voluminous appendices contain correspondence between Isham and others in 1746–1747, a lengthy biography of Isham, and for comparison an account by Andrew Graham, *Observations on Hudson's Bay* (1775). A 12-page index renders easy the location of the many topics in the several sections of the book.

LORUS J. & MARGERY J. MILNE

AMERICAN WILDLIFE AND PLANTS. *A Guide to Wildlife Food Habits: The Use of Trees, Shrubs, Weeds, and Herbs by Birds and Mammals of the United States.* *By Alexander C. Martin, Herbert S. Zim, and Arnold L. Nelson. McGraw-Hill Book Co., New York, Toronto, and London.* $7.50. x + 500 pp.; ill. 1951.

Since the days of the Lewis and Clark Expedition, governmental agencies have found difficulty in reporting results of studies. This book remedies this deficiency in a notable manner for one aspect of wildlife research. Since the 1870's a group of economic biologists has been collecting data on the food habits of wild animals. The agency, now called the Fish and Wildlife Service, has accumulated thousands of cards giving the results of analyses of stomach contents and observations of feeding habits. This material is now summarized in a form that makes it available to zoologists, botanists, horticulturists, and many others.

The first part of the book summarizes in a clear and concise manner the botanical and agricultural aspects of the problem and gives a thorough discussion of the arrangement of the data. The authors describe the pitfalls of interpretation of the data and make a commendable effort to prevent the reader from drawing unwarranted inferences.

The body of the book presents the knowledge of food habits of vertebrates. Naturally, game birds and mammals are best known and receive most of the attention. A discussion of each species or group of species includes a few remarks on habits and a summary of foods eaten. When data are available, seasonal changes are indicated. A map of the range of the species is given. The last section of the book reverses the procedure and tells what animals eat various plants.

Perhaps the most significant aspect of the book is the systematization of knowledge and the indications of future problems. This book points the way to more detailed and more comparative studies. The authors leave no doubt in the reader's mind that the study of food habits is a complex problem.

DAVID E. DAVIS

WILDLIFE IN COLOR.

By Roger Tory Peterson. The Riverside Press, Cambridge; Houghton Mifflin Company, Boston. $3.00. vi + 191 pp.; ill. 1951.

Each year the National Wildlife Federation, an organization whose business is the conservation of the wildlife of America, issues a series of 36 poster stamps by well-known artists. Designed to create an interest in, and to call attention to, the great diversity of plant and animal species found in this land of ours, the stamps have enjoyed a popularity commensurate with their artistic quality. Revenue from their sales has gone to support an active nationwide conservation program. In the present book, Roger Tory Peterson, who painted many of the posters himself, has brought together all of the stamps from the 1939 through the 1951 series into a single volume, grouped them into natural wildlife communities, and provided an excellent commentary to give the stamps substance and meaning. It is, on the whole a commendable effort on the part of the author; but those who, each year, have looked forward to the new issue of stamps will be sorely disappointed with the reproductions. Reduction in size of many of the stamps, and a general muddiness of tone in most, have removed the sparkling clarity and faithfulness of color which made the original stamps such outstanding examples of wildlife portraiture. Those of Weber have suffered less in reproduction than have those of Jaques, while the plants as a group have fared quite badly. It is nonetheless a book to be recommended heartily.

C. P. SWANSON

ZOOLOGY IN POSTAGE STAMPS.

By W. Dennis Way and O. D. Standen. Philosophical Liberty, New York. $5.00. viii + 113 pp. + 32 pl. 1952.

Philately has been described as "the king of hobbies, and the hobby of kings." Certainly it is a subject of interest to a vast audience, and the flood of new issues constantly entering the stamp trade indicates that the various nations of the world are not unaware of the income to be derived from this source. The United States was in the past an exception to this rule, its postal department always operating at a loss despite a reasonable flow of new, if somewhat meaningless, commemoratives. It is not surprising therefore that many nations, particularly those of small size and of poor national resources, are making a considerable effort to create stamps of distinctive beauty. Again, the United States is an exception as to size, resources, and philatelic standards. This trend has found subjects of natural history to be in popular demand. The flower and insect semi-postals of Switzerland, the flower sets of Austria, Hungary, and Colombia, and the exceptionally beautiful tropical bird and fish sets of Angola and Mozambique are outstanding examples of creative philately at its pictorial best. However, zoological philately goes back to the beginnings of postal service, the black swan of Western Australia having been one of the earliest subjects of this kind.

In this volume the zoologist and the stamp collector will find their two fields of interest very nicely integrated in an authoritatively written and well documented manner. The treatment is by zoological groups rather than by country, and from highest to lowest orders rather than by the more customary phylogenetic sequence employed by textbooks. Only the Protozoa are missing in the stamp parade! The systematist may well object to the order of treatment, but this seems a minor point in a book devoted essentially to a consideration of stamps in which animals happen to be the central theme. Also, as the authors point out, a phylogenetic treatment would be somewhat meaningless, since many of the more important links in evolution have not been made available as stamp portraits. Within each group, species are described as to appearance, distribution, habitat, scientific name, and economic value if any, followed by a brief statement, in heavier type, of philatelic interest in which the stamps depicting each species are described as well as the dates and circumstances of their issuance. A spot check of Scott's catalogues showed no obvious omissions. Thirty-two plates on glossy paper provide an excellent selection of the most striking stamps against a black background. As regards the illustrations, a point in the authors' defense is in order. Without doubt the book would have been improved by the inclusion of colored plates; however, such treatment is prohibited by the postal laws in this country except for issues which have been demonetized, and the burden of proof of demonetization rests with the authors and the publisher. Clearly this is a task which few authors would willingly undertake or for which they would wish to assume responsibility.

As a contribution to philatelic literature, the volume will be of greatest interest to those whose topical leanings are in a biological direction. It will, on the other hand, provide the professional zoologist with a good deal of philatelic information bearing the mark of authority.

C. P. SWANSON

THE HOUSEFLY. *Its Natural History, Medical Importance, and Control.*

By Luther S. West. Comstock Publishing Co., Ithaca, New York. $7.50. xvi + 584 pp.; ill. 1951.

In 1914 C. Gordon Hewitt gave the world the first, and up to now, the only great work dealing with the common and almost universally distributed *Musca domestica*. This insect occurs in all temperate regions of the world and in tropical America. It is absent or scarce in tropical Africa, southeastern Asia, and the East Indies, where it is replaced by several other native species. In most subtemperate regions it is replaced by a subspecies, *M. d. vicina*, the habits of which are exactly the same as the typical form. Both forms are equally proficient in the transmission of various diseases, and many students believe that they have caused more human suffering than any other one species of insect.

In his treatment of the housefly West has followed the pattern set by Hewitt in his classic work. The first chapter is an introduction to the housefly and its relatives, particularly in relation to man and his welfare. It is pointed out that up until about 80 years ago flies were tolerated by man: about that time there came a realization that flies might be more than just pests to be brushed away from food; and it was not many years before their capacity for carrying disease was discovered.

Four chapters deal thoroughly with the structure, life history, and taxonomy of the housefly, while chapters dealing with the life of the fly, such as food, influence of temperature, and relationship to the surroundings follow. We go on to learn of the fly's parasites, and its relation to human disease and public health. The concluding chapters on fly control cover the field thoroughly. It is quite apparent that sanitation must play a most important part in all control measures. The "new" insecticides—DDT and related chemicals—are discussed, their "uses and dangers" being pointed out. At the time the manuscript was prepared houseflies were just beginning to demonstrate an immunity,

which is now almost country-wide, to the new insecticides. It is fortunate that no impression is given that the insecticides are a cure-all.

All of the essential facts learned since 1914 have been added to the knowledge presented by Hewitt. West is to be highly congratulated. Public health officers, teachers, and the general public now have available an up-to-date account of one of man's worst enemies.

C. H. CURRAN

BIRDS OF AN IOWA DOORYARD.
By Althea R. Sherman; edited by Fred J. Pierce; forward by Arthur J. Palas. The Christopher Publishing House, Boston. $3.75. 270 pp. + 9 pl. 1952.

Although the reviewer never met Miss Sherman, her description as given by A. J. Palas in a biographical Foreword imprints the idea that she must have been a forceful character. Nor would it take any shrewd deduction to arrive at a similar conclusion from reading her articles. This book, compiled by F. J. Pierce after her death, consists of part of a tremendous accumulation of painstaking notes faithfully recorded during her long and active career as a student of birds. The editor had to select material from about 60 closely written notebooks, as well as from a number of chapters written for a book long-planned but never completed. These notes are being preserved and can be examined by any interested student.

Among the birds included in the present publication are the chimney swift, phoebe, house wren, short-billed marsh wren, the rails, catbird, sparrow hawk, screech owl, and flicker. Aside from nesting observations, there are some interesting reports on the changing bird life that in some cases accompanied the evolution of agricultural practices in Iowa. To study the chimney swifts, Miss Sherman had a special tower built that enabled her to peer at the nesting birds from a distance of a few inches. These reports will be essential for any student concerned with the study of swifts. Of special interest here was the observation of a third adult acting in the role of a nurse-maid to the nest. The murder of young barn swallows by an adult male, the desertion of her young by a female flicker enticed by the drummings of another male, the heavy mortality of young phoebes by lice, are some of the more fascinating topics.

That Miss Sherman was not averse to shaking tradition by the neck is well exemplified by her bold attack on the house wren. This article, among others in the book which were first published in ornithological journals, accuses the wren of being an undesirable aggressor and destroyer. It is recommended that instead of erecting wren boxes, these birds should be discouraged by all possible means. This viewpoint, at the time it was published, created considerable interest. Her most effusive outburst, however, is levied against the "bird lovers" of the "new school." Her opinion is not entirely unjustified, but her rancor exceeds her caution, and the shoe can sometimes fit the other foot—witness her making fun of someone else's interpretation of color change in the scarlet tanager (p. 64), when she is herself not on solid ground. Nevertheless, her writings contain many important facts about the nest life of birds, and although the interpretations of some of their behavioral responses may not be acceptable, the observations and their recordings are sure to be accurate. This book cannot be dismissed as another "backyard" bird book.

HENRI C. SEIBERT

WHERE TO FIND BIRDS IN MINNESOTA. *A Guide to 62 Birding Areas, Parks, and Sanctuaries.*
Compiled by Kenneth D. Morrison and Josephine Daneman Herz. Sponsored by National Audubon Society. Webb Publishing Co., Saint Paul, Minnesota. $1.50 (paper). xiv + 122 pp.; ill. 1950.

Bird students residing in Minnesota or visiting that state are fortunate to have available this guide to good bird areas. For convenience, the state has been divided into 4 sections. Each section is then described as follows: a map showing the town nearest each "birding" area; a list of those "birding" areas; a description of each area, including travel directions, general features of the terrain, vantage points within the area, the more unusual or spectacular birds there, restrictions, hazards, and general information pertaining to the area. These various "birding" places include parks, refuges, camps, islands, lakes, marshes, and other regions eagerly sought by the field student.

HENRI C. SEIBERT

WATERFOWL AND THEIR FOOD PLANTS IN WASHINGTON.
By Charles F. Yocom. University of Washington Press, Seattle. $5.00. xvi + 272 pp.; text ill. 1951.

A little more than one-half of this book is devoted to the ducks and geese known to occur within the state of Washington, and the remainder to a detailed analysis of their food habits. The status of each species is briefly discussed, followed by a more detailed description of the principal nesting areas and by tabular data showing the relative abundance of each resident species. There are chapters describing the effects of hunting and of parasites, the establishment of refuges, and bird migration. These chapters did not impress me as being of very much value. On the other hand, the results ob-

tained from brood studies during 1947 and 1948, and the data on sex ratios and age classes provide invaluable material for future studies in those directions. The section on food habits is one of the most detailed ever assembled for a large group of birds, in that it contains a key to the important food and cover plants of Washington wildfowl. Not only is each species of food plant illustrated, but also the distribution of each is shown on small maps. From an analysis of 251 stomachs, the data are broken down according to preference, geographical distribution, and seasons (only 13 were collected during the summer). Since 174 of the 251 stomachs came from mallards alone, and the rest from 9 other species, it is obvious that some ducks are treated more adequately than others. However, there always has to be a beginning, and this report is an especially good one.

HENRI C. SEIBERT

INTRODUCED MAMMALS OF NEW ZEALAND. *An Ecological and Economic Survey. Dept. sci. indust. Res. Bull., No. 98.*

By K. A. Wodzicki. Department of Scientific and Industrial Research, Wellington, N. Z. 12s. 6d. x + 255 pp. 1950.

New Zealand has been in effect one of the great proving grounds for introductions of exotic animals through human agency, and the impacts of some of these introductions upon once-isolated biota have been very pronounced. Wodzicki's book deals with the case histories of the chief problem mammals, including ungulates, lagomorphs, rodents, and mustelids. It may be recommended not only to biologists and students of causes and effects, but also as reading for those sportsmen and game administrators who think that the big problems of wildlife management may be solved by introducing more and more foreign species.

PAUL L. ERRINGTON

MAMMALS IN THE HIGHLANDS OF SOUTHERN PERU. *Bull. Mus. comp. Zool., Harvard College, Vol. 106, No. 3.*

By Oliver P. Pearson. Museum of Comparative Zoology, Harvard College, Cambridge, Mass. $1.50 (paper). Pp. 117–174 + 8 pl. 1951.

32 species of wild mammals and 10 domestic species live on the Altiplano. This paper discusses their occurrence, geographical relationships, problems of survival, and provides notes on the distribution, description, and habits of each wild form. There is a list of the mammals and a key to the rodents, which are of course the most varied group (23 species).

THE DUSKY-FOOTED WOOD RAT.

By Jean M. Linsdale and Lloyd P. Tevis. The University of California Press, Berkeley and Los Angeles. $7.50. x + 664 pp.; ill. 1951.

The Wood Rat continues to attract the attention of scientists who value knowledge for its own sake. Years ago, Howell studied the anatomy of one species; and now Linsdale describes the life history of another kind (*Neotoma fuscipes*). The book is an example of a thorough study carried out for a decade. All aspects of the Wood Rat's biology are described in a series of chapters on habitat, houses, animal associates, behavior, food, reproduction, morphology, and population. The reader will enjoy and appreciate the detailed descriptions of these aspects.

Linsdale follows a definite philosophy of scientific writing. He records as many details as possible, so that the reader may draw his own conclusions. Unfortunately, this philosophy has its deficiencies, for the reader cannot be as competent as the actual investigator to interpret the data. The danger is that inadequate and incorrect interpretation may result. Consider, for example, the chapter on reproduction. A mass of excellent data is presented but rarely a conclusion or summary. The reader searches in vain for a clear statement of the extent of the breeding season, although the data on pages 392–395 are tantalizing.

A disappointing aspect of this situation is that many good data are wasted because the author did not attempt to compare his data with conclusions from other workers. It is certain that Linsdale has data that would give the mortality rates of the Wood Rat, yet the tedious tables 124–132 indicate merely the disappearance of rats from the area.

These deficiencies are remedied only in part by the brief chapter of conclusions (5 pages). A valuable addition would have been a comparison of the life history of the Wood Rat with that of other species that have been thoroughly studied and a discussion of the application of data from this study to general biological problems.

The data in this book show that the Wood Rat is a conventional rodent. It stays near home unless forced to move by unfavorable circumstances. It breeds mostly within a short period of time in the spring, raises a couple of litters of about 3 young, and is inactive for the winter. The food is largely vegetable and is found near the nest-house. The life of the average Wood Rat is short, probably less than 2 years. The size of the population is determined primarily by habit factors, although predators and disease play a role.

DAVID E. DAVIS

RANGE MANAGEMENT. *Principles and Practices.*

By Arthur W. Sampson. John Wiley & Sons, New

York; Chapman & Hall, London. $7.50. xiv + 570 pp. + 2 pl.; text ill. 1952.

The lifetime experiences on range management of a great scientist and keen observer are here packed into 24 chapters covering the subject on a worldwide basis. The book is divided into four sections: Range Management in Perspective; Native Range Forage Plants; Improvement and Management of Range and Stock; and Protection of Land Resources and Range Livestock. It is critically and adequately illustrated.

The author points out that the states west of the 100th meridian are basically dependent on the range for their major agricultural income. Maximum returns from rangeland have not been obtained because of a lack of understanding of the proper use of this basic resource.

Sampson applies range management principles and current sound practices in presenting his subject. In the first section the relationship between the number of livestock on the range and management principles is stressed; world grazing practices and problems are considered; the physiology and ecology of range plants and the forage and species characteristics of American grazing lands are given. Descriptions and characteristics of the native range plants are given in Part 2. The management of range species for maximum use and conservation, reseeding either naturally or by artificial means, and the control of undesirable woody and poisonous plants are fully discussed. A consideration of provision for water, supplemental feeding, and livestock care and management as related to range use gives a balanced study and evaluation of our range resources and their wise use and development.

The reader or student will get an accurate interpretation of a gigantic basic natural asset, our rangelands, from this book. He will also be impressed by the facts presented on the conservation, management, and use of this little understood but important phase of agriculture.

GILBERT H. AHLGREN

THE NORTH AMERICAN BUFFALO. *A Critical Study of the Species in Its Wild State.*

By Frank Gilbert Roe. University of Toronto Press, Toronto. $12.00. viii + 957 pp. + 1 pl. 1951.

This is a remarkable book by a man referred to on the jacket as "an Albertan old-timer . . . a self-taught scholar, leaving school to commence work when not yet eleven years of age." Historian rather than biologist, the author has carefully studied the available testimony as to the habits, numerical status, and fortunes of the American bison since discovery of the species by the white man. His treatment of material within the scope of his essay—which he describes as "one long criticism of futile generalizations"—is not only exhaustive and very well-documented but also realistic and objective.

Plenty of early writers and some of the modern get spanked in this book for their biases and irresponsible handling of the known and apparent facts, but, so far as I can see, with fairness. At the same time, those who demonstrated reliability receive commendation about to the extent deserved. Hornaday and Seton, among the "three serious historical generalizers on buffalo" (the third being J. A. Allen, "incomparably the best"), show up badly in this respect, though their accomplishments in other ways are appreciated.

The book should be an especially desirable acquisition for institutional libraries, for its contents include much information of interest and value to a wide range of readers—sociologists, economists, and anthropologists, as well as biologists and historians. To me, some of the most distinctive contributions are the author's discussions of the movements of the herds, of the influence of the once-great buffalo-economy on Indian mentality and customs, of the impacts on Indians and their sustaining resources by conscienceless white invaders. It is good to read his defense (pp. 7–8 and elsewhere) of George Catlin, long abused for sympathizing with the Indians during the exploitative years of the 19th Century, when sympathy for and understanding of Indians were unfashionable, if not publicly discouraged.

PAUL L. ERRINGTON

TARKA THE OTTER. *His Joyful Water-Life and Death in the Country of the Two Rivers. Second Edition.*

By Henry Williamson; with an introduction by The Hon. Sir John Fortescue. E. P. Dutton & Company, New York. $3.00. xiv + 260 pp. 1949.

A vivid story of the life of an English otter, this minor "classic" is so filled with strange words from the vocabulary of British otter hunters and the dialect of Devon that to an American the flow of thought and action is often unbearably impeded. To all such one may recommend the charming, simply told story of Phyllis Spurway's pet otter, in *The Otter Book* (*Q.R.B.*, 20: 392. 194), which has the additional advantage of the author's striking photographs. Nonetheless, *Tarka the Otter* has an atmosphere and a magic quite its own. It will be surprising if, in the end, it does not outlive its rival.

BENTLEY GLASS

FALL OF THE SPARROW.

By Jay Williams; with an introductory chapter by Stanley Edgar Hyman; illustrated by Richard Taylor.

Oxford University Press, New York. $3.00. x + 157 pp. + 8 pl. 1951.

A popular account of the extinctions of species of birds and mammals that have occurred within historic times. The point is well made that these have been largely due to man's destructive influences and that great and continual effort must be exerted by groups interested in preventing further occurrences of this sort. This point not only recurs as a theme throughout the book, but is the subject of a separate chapter Saving Grace. Although the book should accomplish its objective of interesting lay readers in the biology and problems of extinctions very well, yet much of the information given is presented in such a generalized and often flippant manner that any serious reader who might intend to put this information to use in lectures or other ways is advised to check more original sources. Although the style is such as to attract popular attention, several chapters lack continuity.

JOHN CUSHING

EVOLUTION

THE PHYSICAL BASIS OF LIFE.

By J. D. Bernal. Routledge and Kegan Paul, London. 6s. 80 pp.; ill. 1951.

This lecture deals in stimulating fashion with the problem of the origin of life. Bernal's ideas are based upon those of Haldane, Lwoff, Oparin, and Dauvillier, which he has correlated and to which he has added penetrating observations of his own. His picture of the primeval environment is an atmosphere of nitrogen with gradually diminishing CO_2, and a sea containing in solution ammonia, carbon dioxide, hydrogen sulfide, and halides. It was, of course, out of the reactions of CO_2 and NH_3 that the first nitrogenous organic compounds were derived. To get around the difficulties of the extreme dilution of the system, Bernal prefers to have recourse to the adsorptive action of clay particles rather than to the coacervate theory of Oparin. The impossibility of the formation of such polypeptide and protein substances today is attributed to the cutting off of the ultraviolet by the formation of the ozone layer in the atmosphere, as well as by the universal presence of life itself, that would at once incorporate and use such molecules if they arose. Bernal equates the origin of life with the first occurrence of "steady interactions between complex molecules in a general medium," whereas the first organism was formed "when a section of this medium was separated out, sufficiently large to contain a self-maintaining system of reactions with the medium." The importance of the sulfhydryl groups and the porphyrin compounds is emphasized, and the relation of respiration to photosynthesis is discussed briefly. Perhaps the most interesting point in the entire presentation is the graphic representation of a sequence of stages: (1) primary inorganic ultraviolet photosynthesis; (2) primary dark katabolic life; (3) primary ultraviolet photosynthetic life; (4) effect of ozone layer; (5) rise of photosynthesis by visible light. Living organisms would originate in stage (2). The presence of O_2 in the atmosphere is supposed to begin with the third of these stages, at which time also the hydrosphere would be marked by a diminution of the free complex molecules to negligible amounts and the occurrence of a variety of inorganic ions. The chemoabsorption of sunlight by organisms would show successively increasing peaks in stages (2), (4), and (5).

Bernal concludes with a consideration of the evolution of the cell. Except for the introduction of tactoids, this part of the lecture is relatively undeveloped, as might be expected, since a cytologist may well take over at this point.

It is surprising that Bernal takes no account of Horowitz' now famous hypothesis of the backward evolution of biochemical syntheses, which offers so helpful a solution of the problem of the origin of long reaction chains when only the final product appears to be of use to the organism. (This view has recently been further elaborated by Blum and especially by Lanham.) On the other hand, Bernal reveals an acquaintance with the continental literature dealing with evolutionary theory about the origin of life that will send most American students of the subject hurrying to the library.

BENTLEY GLASS

THE LADDER OF LIFE. *From Molecule To Mind. Thrift Books No. 4.*

By A. Gowans Whyte. C. A. Watts & Co., London. 1s. (paper). 119 pp.; ill. 1951.

The author has attempted to throw some light on the "mystery of mind" by tracing for the general reader a bit of the history of the evolution of the nervous system. In spite of some inaccuracies, the book should interest the general reader.

ELLA THEA SMITH

CATALOGUE OF THE FOSSIL CEPHALOPODA IN THE BRITISH MUSEUM (NATURAL HISTORY). *Part V. The Ammonoidea of the Trias (II).*

By L. F. Spath. The British Museum, London. £1 15s. xv + 228 pp. 1951.

The first three parts of this valuable *Catalogue of the Fossil Cephalopoda in the British Museum* (*Nat. Hist.*) were devoted to the Paleozoic cephalopods. In 1934, after a long interval of time, Part IV was issued, in which L. F. Spath started with the description of the

Ammonoidea of the Trias. This covered the 4 superfamilies Pronoritida, Xenodiscida, Meekoceratida, and Phylloceratida, as well as the first part of the Ceratitida. The present volume concludes the survey of the superfamily Ceratitida (amongst it the new families Danubitidae, Balatonitidae, Proteusitidae, and Aploceratidae) and deals with the superfamilies Trachyceratida (new families: Thisbitidae, Noridiscitidae), Tropitida (new families: Tropiceltitidae, Metasibiritidae), Lobitida, Arcestida (new family: Nathorstitidae), Ptychitida (new family: Isculitidae), and Pinacoceratida. In the taxonomy of Spath the Ammonoidea of the Triassic thus comprise 11 superfamilies, with 64 families and 388 genera. Some 40 new genera have been erected by the author in the course of compiling the *Catalogue*. A lot of new species have also been named, though in this part, contrary to the foregoing ones, no detailed descriptions of species and no localized lists of the registered specimens in the British Museum have been given. Unfortunately, also, every illustration has been omitted, partly due to the circumstances of the time and partly to avoid a further delay in the publication of this part. W. N. Edwards, in his Preface, however expresses the hope "that a separate volume of ilustrations will be issued in due course." This will be highly welcome and will even be absolutely necessary for a full understanding of the wealth of new facts brought forward in this part. An extensive and apparently nearly complete list of literature and a detailed index conclude the volume. Spath has created a standard work indispensable for every one concerned with fossil ammonoids.

OTTO H. SCHINDEWOLF

SEDIMENTARY FACIES IN GEOLOGIC HISTORY. *Conference at Meeting of The Geological Society of America Held in New York, New York, November 11, 1948. The Geological Society of America Memoir 39.*

Edited by Chester R. Longwell; papers by R. C. Moore, E. D. McKee, S. W. Muller, E. M. Spieker, H. E. Wood 2nd, and L. L. Sloss, W. C. Krumbein, and E. C. Dapples. The Geological Society of America, New York. $1.75. viii + 171 pp. + 5 pl.; text ill. 1949.

The heterogenous contributions of 8 principal and 9 additional authors (in discussions) make a difficult subject for a reviewer. As the chairman of the conference pointed out, the discussion of a subject "so large and many-sided" is apt to "include geologists familiar with the physical and organic evidence in diverse stratigraphic sections" and "ecologists with knowledge of the varied domains of plant and animal life." However, the principal speakers had little to say about the organisms involved, and the chief contributions in this respect were furnished in the discussion from the floor. Thus S. W. Lowman presented an excellent summary on the recent marine facies of the Gulf of Mexico and on their Quaternary and Tertiary counterparts, as revealed by the numerous bore-holes on the territory of the Gulf Coast drilled by various oil companies. Equally comprehensive is Daniel T. Axelrod's discussion of the late Tertiary woodland floras in the western and southwestern states, and an explanation of the method of their geologic dating, worked out in the course of the last 15 years by Ralph W. Cheney and his school of botanical paleoecologists. It is accompanied by 3 paleoecologic maps, showing successive pushing to the north and east of the "Arcto-Tertiary" terrestrial flora by its southern rival, the "Madro-Tertiary" flora. This is the latest summary of the climatic history of our West during the Oligocene, Miocene, and Pliocene epochs.

In various degrees useful geologically, but mostly already previously reported by various authors, are the data compiled in the paper by R. C. Moore, the first in the program. Original is the presentation by L. L. Sloss, W. C. Krumbein, and E. C. Dapples of their method of "integrated facies analysis," with a view to synthesize the "separate paths" of exploration: lithologic, biologic, and tectonic; and their expression of the results in the form of a few generalized maps of "lithofacies" and "tectofacies" of some selected geologic ages.

E. D. Mckee's paper is devoted to the sequence of change in the marine facies of the geologic column in the Colorado Plateau; mostly as observed in the Grand Canyon of Arizona—but no data of biologic interest are incorporated. The same can be said about Siemon W. Mueller's presentation of similar data from the marine Triassic in central Nevada. More ambitious is E. M. Spieker's summary of his long-range work on the Upper Cretaceous of Utah and adjacent parts of Colorado, which reveals a detailed interrelationship of various marine and terrestrial facies, in the course of geologic time. However, he too barely mentions the biologic element in the complex subject of the facies.

H. E. Wood, 2nd, furnishes a short, but a more nearly balanced summary of the Oligocene (White River) terrestrial facies of the northern mid-continent. He concludes that they present such a complex mosaic of facies, some being "extreme variants," that at present "far more problems await solution than have yet been solved."

Excellent contributions by the discussants (besides the two mentioned at the beginning of the review) deal with the difficulties of decision whether there is facies change or time change when one geologic formation replaces another laterally (by John Rodgers); the relation between geosynclines and their sediments to the diastrophism (by Andrew Lawson and Marshall Kay); the complexities of sedimentation as controlled by its

changing sources, and the role of "finely disseminated carbon" in producing a similar dark shade in rocks of "divergent composition" (by W. M. Cady); the dangers of over-simplification and the necessity to pursue lithologic, mineralogic, and biologic approaches analytically independent and therefore unbiased by each other, with a view to eventually integrating them all when attempting to solve the problem of contemporaneity (John C. Griffith); the significance of black shales in relation to other sedimentary facies (by Robert I. Roth); the origin and significance of the "red beds" in the Mesozoic formations (by Franklin B. Van Houten); and the technical problem of stratigraphic terminology in expressing the observed facies and their relationship to each other (by Philip B. King).

On the whole, this is a symposium of great usefulness to professional stratigraphers, but, with the exception of the two contributions first mentioned, it has little to do with the biologic factors involved in sedimentation.

M. K. ELIAS

GEOLOGY AND ORIGIN OF SOUTH PARK, COLORADO. *The Geological Society of America, Memoir 33.*

By J. T. Stark, J. H. Johnson, C. H. Behre, Jr., W. E. Powers, A. L. Howland, Don B. Gould, and others. The Geological Society of America, New York. $3.75. viii + 188 pp. + 14 pl. + 3 maps + 1 chart; text ill. 1949.

Devoted largely to the descriptive geology of the area, chiefly south and east of Fairplay, Colo., the memoir is also an ambitious joint attempt to explain the geologic origin of the peculiar, relatively broad and flat valley of the "South Park" in the midst of the rugged mountains of the Rockies.

The well executed geologic map may be advantageously used by visitors to the area, who may wish to add to their tourist pleasure an understanding of the geology at this picturesque and fairly accessible (best from Colorado Springs) part of the Rockies.

Of special interest to paleontol ?ists and biologists is the intriguing locality of the fossil insects (20 species), which belong either to Triassic (Scudder, 1890) or to Permian (David White, 1912) age; it is located somewhere "on the Nelson Ranch, nearly four miles southeast of Fairplay." However, it needs to be rediscovered in order to get new fossil material for study, and to determine its exact position in the local geologic section. A personal attempt of my own to rediscover it in 1944 was unsuccessful, and the ensuing correspondence with the paleontologists, who presumably knew something about it, was equally futile. The area in question is an open, easily accessible (with owner's permission) lowland, with many exposures of the "red beds," occasionally containing distinct plant impressions. Though mapped as Permian, the uppermost (easternmost "red beds" may well be (as I think) of Triassic age, being overlain conformably by the Jurassic formations of the eastern flank of the valley.

M. K. ELIAS

GEOLOGY OF THE LAKE TITICACA REGION, PERU AND BOLIVIA. *Geol. Soc. Amer. Mem. 36.*

By Norman D. Newell. The Geological Society of America, New York. $5.00. x + 111 pp. + 17 pl.; text ill. 1949.

The stratigraphy of the Devonian to Tertiary rocks of the Lake Titicaca region is considered here, but little is said about fossils themselves. A chapter on the geography of the region deals briefly with its climate and agriculture, among other topics. There are excellent reproductions of photographs of the regional topography.

THE VERTEBRATE FAUNAS OF THE LOWER OLD RED SANDSTONE OF THE WELSH BORDERS. PTERASPIS LEATHENSIS WHITE—A DITTONIAN ZONE-FOSSIL. *Bull. Brit. Mus. (nat. Hist.)—Geology, Vol. I, No. 3.*

By Errol Ivor White. British Museum (Natural History), London. 7s. 6d. (paper). Pp. 49–89 + 5 pl.; text ill. 1950.

A NEW CLARENDONIAN FAUNA FROM NORTHEASTERN NEVADA. *University of California Publications—Bull. Dept. Geol. Sci., Vol. 28, No. 7.*

By J. R. Macdonald. University of California Press, Berkeley and Los Angeles. 50 cents (paper). Pp. 173–194; ill. 1949.

GENETICS AND CYTOLOGY

THE PRINCIPLES OF HEREDITY. *Fourth Edition.*

By Laurence H. Snyder. D. C. Heath & Co., Boston. $4.75. xii + 515 pp.; ill. 1951.

Among the leading textbooks of genetics, Snyder's remains notable for its emphasis upon the genetics of the human species itself. In the new edition, many parts of the text have been revised in the light of the rapidly developing field of genetics. Some of these sections deal with the genetics of domestic animals, cytoplasmic inheritance, biochemical and physiological genetics, sex determination, and the induction of mutations by chemical mutagens. The most extensive and interesting aspects of the revision, however, are those that relate specifically to human genetics. The discussion of blood group inheritance has been brought

up to date; and population genetics has been discussed in terms of mutation pressures, selection pressures, and genetic drift interacting with migration and interhybridization. By far the most original contribution to the new edition is the chapter on Eugenics, which now presents views greatly modified from those formerly held by the author. Snyder has presented a truly excellent evaluation of the potentialities and weaknesses of both positive and negative eugenic proposals. This chapter alone renders the earlier editions obsolete, and stands forth as the best treatment of the subject in any general textbook at the present time. It is urgently recommended for study, not only by those in the field of genetics itself, but also by medical men, anthropologists, and above all by the self-styled "eugenists."

BENTLEY GLASS

THE GENETICS OF MICRO-ORGANISMS.

By D. G. Catcheside. Pitman Publishing Corporation; New York, Toronto and London. $4.50. viii + 223 pp.; ill. 1951.

As the first book in a highly active and relatively new field, this account of microbial genetics should attract considerable attention from both geneticists and biochemists. After the reader has stubbed his toe on page one over the word *propagulum* he will soon learn that Professor Catcheside speaks softly and carries a big vocabulary; the technical language of classical genetics is reinforced by both new words from the microbiologists, and the details of such processes as the interaction of antepenultimate cells of ascogenous hyphae with the uninucleate crozier. Maximum benefit will go to those possessing at least a nodding acquaintance with the subject.

In common with many introductory treatises, entities that appear nebulous to the professional researcher are categorically defined. This may be necessary to establish a basis for discussion. Thus both gene and plasmagene are nailed down in the Introduction, no small feat in itself. A brief account of cytogenetic principles follows, together with a description of segregation, recombination, and heterocaryosis in *Neurospora* and other fungi. This is followed later by a condensed survey of the diverse reproductive systems of both fungi and algae. The contribution of mutation to a knowledge of biochemical synthesis is established by appropriate examples, and some possible limitations of the one-to-one relationship between gene and enzyme are discussed. Adaptation and mutation are considered, with special emphasis on the enzymatic consequence of mutation and the possibility of induced changes of a directive nature.

Special chapters are devoted to the genetics of yeast, protozoa, bacteria, and viruses. Inevitably, in so short a book, much of importance has been left out. The rapid development of microbial genetics has invalidated certain conclusions, and recent findings are unavoidably omitted. Among the latter may be included the discovery of transduction, new work on the transformation of resistance properties, specificity in the action of mutagens, and the existence of recombination in bacterial genera other than *Escherichia*. We may hope that a new edition will remedy these deficiencies, although it is the nature of a rapidly advancing science to stay ahead of even the most conscientious author.

VERNON BRYSON

LES APPLICATIONS DE LA GÉNETIQUE À LA MÉDECINE. *Second Edition.*

By Maurice Lamy. G. Doin & Cie., Paris. 75 fr. (paper). 146 pp.; ill. 1944.

This book constitutes an elementary treatment of the application of the principles of genetics to medicine. The text is kept simple by design, and should appeal to the medical student or worker who has little or no previous background in genetics and who desires a quick introduction to human genetics at its simplest level. Topics covered include an introductory chapter on principles, discussions of dominant and recessive autosomal inheritance, sex-linked inheritance, crossing over, multiple alleles, mutation, factor interaction, heredity and environment, and a brief survey of certain genetically determined pathological traits in man.

VERL L. HOUSE

LECTURES ON GENETICS, CANCER, GROWTH, AND SOCIAL BEHAVIOR. *Given in Honor of Dr. C. C. Little. Roscoe B. Jackson Memorial Laboratory Twentieth Commemoration, 1949.*

Contributors: W. E. Heston, Howard B. Andervont, John J. Biltner, Warren H. Lewis, L. C. Dunn, Charles Huggins, and Benson E. Ginsburg. Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine. $1.00 (paper). 124 pp. 1949.

This American example of a Festschrift is not equal in format to many European examples, but its substance is most worthwhile. The idea of getting former research associates and students at the Roscoe B. Jackson Memorial Laboratory to discuss the varied aspects of work in the field within which the Laboratory has so distinguished itself, was an admirable one. The contributors are all well-known figures in the fields of cancer and growth research, of genetics or animal behavior. Their subjects are as follows: Development of Inbred Strains in the Mouse and their Use in Cancer Research (W. E. Heston); The Present Status of the Mammary Tumor Inciter Problem (Howard B. An-

dervont); Factors Associated with the Genesis of Mammary Cancer in Mice (John J. Bittner); Gel Layers of Cells and Eggs and their Role in Early Development (Warren H. Lewis); Some Relations between Mutations and Abnormal Development (L. C. Dunn); Alkylating Reactions in Genetics and Cancer Research (Charles Huggins); and Genetics and Social Behavior—a Theoretical Synthesis (Benson E. Ginsburg). Each paper is preceded by a brief note on the contribution to that subject made by the Jackson Laboratory. Thus the publication achieves a degree of unity which is decidedly lacking in most such compilations. The sole striking lack is that of a bibliography of the man here so truly honored, C. C. Little.

BENTLEY GLASS

PEDIGREES OF NEGRO FAMILIES.

By R. Ruggles Gates. The Blakiston Company, Philadelphia and Toronto. $5.50. viii + 267 pp. + 1 plate; text ill. 1949.

The character of this book is sufficiently indicated by the title. It contains an extensive consideration of pedigrees of North American negro families, mostly as reported by students of the author. Little is developed in the way of new knowledge of the modes of inheritance of particular traits, although the author does present a theory of skin color inheritance based on the cumulative action of 3 factor differences between negroes and whites in place of the classical 2-factor theory. There is included a color plate of 9 shades for use in more accurately classifying skin color. Students of human genetics or ethnology will find the work a useful reference.

BENTLEY GLASS

GENETICS OF SPECIES DIFFERENCES IN THE MORPHOLOGY OF THE MALE GENITALIA OF XIPHOPHORIN FISHES. *Bull. Amer. Mus. Nat. Hist., Vol. 95, Art. 7.*

By Myron Gordon and Donn Eric Rosen. American Museum of Natural History, New York. 75 cents (paper). Pp. 409–464; 2 pl.; text ill. 1951.

GENERAL AND SYSTEMATIC BOTANY

BOTANY.

By Carl L. Wilson with line drawings by Hannah T. Croasdale. The Dryden Press, New York. $6.10. xii + 483 pp.; ill. 1952.

This book is a most attractive textbook for the college botany course or for one's own library. From its covers through every page it is strikingly different and interest-provoking in format. The use of color (red) in the printing of labels and guide lines, page headings, and the framing of photographs and line drawings is an innovation in illustrating texts. And better yet, after being attracted to the text one is not "let down," for it is well written, too. One admires, particularly, the clarity with which significant facts and principles are presented, not only from the standpoint of the use of the English language but also in terms of good, accurate scientific writing. The treatment is comprehensive without being too complex or wordy, it is informative without being too difficult or dull, it is understandable without being too elementary or oversimplified to gain the respect of the college student.

The author indicates that the textbook is intended for a year's course in introductory college botany, but that it may be adapted to a shorter course. The first 18 chapters are about the structure and activities of flowering plants, while the last 12 chapters deal with a survey of the plant kingdom. If the evolutionary thread seems a little too obscure to some, or if there is specific shortage of subject matter in certain areas, or if pet objectives are not met, the instructor using the textbook ought simply to feel a challenge to "fill in" in his lectures, demonstrations, and laboratory work with the same quality of workmanship. While this is a book admittedly designed for the general student, as textbooks go this one should go a long way toward helping an alert, able, and interested instructor to attract students to the field of botany. The explanation of the anatomical features and physiological processes of plant life which "relate to the life of the student and to society in general" are particularly well handled. Whether the student is studying about hybrid corn, the significance of sexual reproduction, the Plant Plan and its Modifications, The Matter and Mechanics of Cells, Photosynthesis and the Leaf, Natural Cycles and Plant Life, or Bacteria and Man, the relating of the plant as a living organism to other organisms and even of plants to "World Affairs" is well done but not overdone.

Mention should be made of the new and quite excellent line drawings by Hannah T. Croasdale, and one always welcomes new photographs that really teach a point. These things furnish not a little of the real impact of this textbook. The summaries at the ends of chapters, the glossary of terms in the back of the book, and a really adequate index are all good points. There is one word of warning. The reviewer tried the book on two red-green colorblind students, and to them the labeling was not only less attractive and less striking but even "fuzzy" and ineffective. I trust this will not influence anyone against the use of a textbook which so nearly fits a "golden mean" in regard to content.

CARROLLE E. ANDERSON

MANUAL OF PHYCOLOGY. *An Introduction to the Algae and Their Biology.*

Edited by Gilbert M. Smith. The Chronica Botanica Company, Waltham, Mass.; Stechert-Hafner, New York. $7.50. xii + 375 pp.; ill. 1951.

A remarkable number of today's leading phycologists have contributed to this volume, and within his limited area, each of the 17 authors was given a free hand to treat his subject as he saw fit. These authors represent many of what might be called different schools, and thus a most interesting series of comparisons may be drawn.

The book opens with a chapter on the History of Phycology, by G. W. Prescott. This chapter records briefly the course of the science through its taxonomic and morphological stages, with little reference to the experimental aspects. The basis for the systematic arrangement utilized in the remainder of the text is presented by the Editor, G. M. Smith, in a brief chapter wherein the algae are segregated into 7 divisions (phyla) on the basis of what are considered to be the best grounds available today. The phyla are each covered by a different author, as follows: M. O. P. Iyengar (Madras, India), Chlorophyta; T. L. Jahn (Univ. of Calif. at Los Angeles), Euglenophyta; F. E. Fritsch (Univ. of London, England), Chrysophyta; H. W. Graham (U. S. Fish & Wildlife Service), Phyrrophyta; G. F. Papenfuss (Univ. of California, Berkeley), Phaeophyta; Francis Drouet (Chicago Mus. of Nat. Hist.), Cyanophyta; Kathleen M. Drew Baker (Univ. of Manchester, England), Rhodophyta. Perhaps only such an editor as G. M. Smith, holding the universal respect of all phycologists, could have brought together such a notable assemblage of contributors.

As is not unusual in such treatises by many authors, inconsistencies crop up. In many cases, in the present work, this is due to the practical completion of the manuscript about 1946 and the seemingly unnecessary series of delays, on the part of the publisher, that have resulted in its issuance in 1951. In any event, one finds no provision in the systematic treatment for the chloromonads, though they are considered as a separate phylum, the Chloromonadophyta, in the first chapter. One could have hoped for expansions of the discussions of such groups as the coccolithophores and the silicoflagellates, and the relatives of *Chrysococcus*—the first for reasons of expected importance in oceanic productivity, and the latter because of their importance as indicators of conditions in fresh-water sources. A similar discussion of the diatoms would have been most welcome. One would have relished finding that, in line with current opinion, the Vaucheriaceae were included among the Chrysophyta.

Both the chapter on the Euglenoids and that on the Pyrrophyta (dinoflagellates and their relatives) have been written by individuals who have made these particular groups their special concern, and who are not otherwise concerned with general phycology. They have presented treatises that appear to be unusually critical, both in actual content and in evaluation, with probably proper disregard for the conventionalisms that many of our otherwise professional phycologists would have included, or have excluded with obvious twinges of conscience. The systematic coverage of the remainder of the groups is generally excellent, but sometimes from strongly diverse points of view. Most of the chapters are definitely what might be termed progressive. Some are most conventional. Some chapters include such eminently refuted ideas as that of ". . . immense floating masses [of algae] in the Sargasso Sea. . . ."

The sections discussed above occupy the first half of the book, and form essentially the systematic and morphological materials customarily taught in courses on the algae. The last half of the book represents to a large extent material of the marginal research-area which is not yet common knowledge among phycologists. This last half of the book would be, indeed, sufficient excuse for its publication. Once again, the delay in publication has outdated some of the details and has prevented the inclusion of some matters of importance, such as synthesis of the interesting information in Hartmann's recent volume on relative sexuality, which was not available when the chapter on the Sexuality of Algae was completed. G. M. Smith, who undertook to present this difficult subject himself, has clearly laid out the general course of the physiology of sexuality in the algae and in addition the major points in Fritz Moewus's various schemes. It can be hoped that this clear and readily understandable treatment may lead more students to undertake experimental work in this critical area. This possibility of encouraging experimental work with the algae by clear presentation of the problems would alone justify the inclusion of any of these later chapters, and indeed is a more worthy reason for their inclusion than the mere organization and recitation of information.

With characteristic attention to detail, H. C. Bold has treated the cytology of the algae in what is perhaps the most thoroughly documented chapter in the book. Certainly this chapter will form a firm starting point for cytological studies in the future. The same can be said for the chapters by H. H. Strain and L. R. Blinks. Strain, who has done a major share of the work on pigments individually, is certainly the person best qualified to discuss them pigment by pigment and group by group. Probably for the first time, current knowledge of algal pigments is presented here in a separate chapter together with a résumé of the various, often inconsistent, reports of pigments from the older literature. The more purely physiological and biochemical aspects of phycology are treated by L. R. Blinks, who has sifted the literature thoroughly and with care in order to present the topical aspects of his subject in a

manner that not only reveals the several aspects of general physiology but further suggests their application to explanations of the relationships of the algae to their environment. This attitude is commendable, for regrettably one must report that a majority of other physiologists carefully isolate themselves from considerations of the systematic or ecological significance of their endeavors.

The ecology of the freshwater algae, by L. H. Tiffany and of the marine algae, by Jean Feldmann, is presented in 2 well organized chapters. Tiffany has organized and presented a careful résumé of our distributional knowledge, largely habitat by habitat. Feldmann has emphasized, as well, life forms. Both chapters, like most treatments of ecology, are conspicuously ingenious classifications of the available observations. Experimental work with ecological implications is largely restricted to the previous chapter on algal physiology and to the following chapter on the Plankton Algae and Their Biological Significance, by Bostwick H. Ketchum. Ketchum has presented rather neatly the probable roles of various physical factors, as currently understood, largely from the point of view of their bearing on productivity in the marine environment. This is a most important aspect which has usually been overlooked in the past by ecologists.

Two sections on technique close the book. The first, on methods for the cultivation of algae, is by E. G. Pringsheim; and the second, on micro-technique, is by D. A. Johansen. Each chapter is limited in scope, the first being concerned almost exclusively with small or flagellated freshwater forms, and the second with methods of commercial slide production.

One is impressed throughout with the lack of awareness most authors display of the *sort* of material included in the remainder of the book; notable exceptions have been pointed out. The editor has been eminently successful in eliminating overlapping, and there are few serious gaps. The industrial aspects of algae are perhaps the only major gap that might well have been filled. One would like to close this review with a comparison of the apparent objectives of each author, their points of view, and the highly individualistic character of the uniformly excellent work of each. This cannot be done briefly and in the confines of a short critical review. All students of phycology should have the opportunity of making such a comparison for themselves. The perusal and study of this book will provide just that opportunity.

MAXWELL S. DOTY

TAXONOMY OF VASCULAR PLANTS.

By George H. M. Lawrence. The Macmillan Company, New York. $7.95. xiv + 823 pp.; ill. 1951.

It is generally felt that systematic botany has suffered for many years from the lack of a satisfactory textbook. This is shown by the fact that at least 4 new taxonomy textbooks have been currently under preparation. Lawrence's *Taxonomy of Vascular Plants* is the first of these to appear. It is, therefore, of great interest to examine this work and to evaluate it as to its fulfillment of the requirements of a satisfactory textbook, thus assisting potential users in assessing its suitability for their purposes.

Textbooks, generally, may be sorted into those that are concise, usually expressing principally the author's own methods, viewpoints, and objectives, and those which are encyclopedic, attempting to cover all viewpoints and all aspects of the subject, usually with greater objectivity. Lawrence's book is very definitely of the latter sort. It is the sort of compendium that will be of fully as much importance as a reference work for the professional taxonomist as it will be to the beginning student— if not, indeed, more. Much of the current taxonomic output would certainly be improved if its authors would study, carefully, the first 14 chapters in this connection.

The book is organized along logical lines, with the first part, consisting of 14 chapters (331 pp.) devoted to Principles and Practices of Plant Taxonomy. The second part (400 pp.) presents short discussions of a selected list of families of pteridophytes and seed plants. These are chosen on the basis of their presence in the flora of the United States, either as native, naturalized, or cultivated plants. Since this includes by far the majority of plant families, it seems a pity that the remainder could not have been included so as to make the book serve better as a handy reference. The families are arranged according to the Engler sequence, although the author carefully emphasizes that this is for the sake of convenience only.

Two appendices, one providing a short syllabus or lecture outline for a course, which may seem to some a bit superfluous, and the other a well-illustrated glossary, and an extensive index to the contents of the book, finish the volume.

The author's definition of taxonomy includes "identification, nomenclature and classification of objects." Not many systematic botanists will be likely to agree to this, nor do the several major dictionaries of the English language. His employment of taxonomy and systematic botany interchangeably is loose usage, that might pass in conversation but should scarcely characterize a textbook. The inclusion of nomenclature in taxonomy further propagates a confusion which is already too widespread.

The first 2 chapters are introductory, Introduction and Taxonomy and its Significance, respectively. The latter elaborates upon the place of this science in the general scheme of things, upon the problems it considers, and upon the opportunities it offers. It is curious that, in this chapter, the taxonomy of cultivated plants

is almost neglected, though the author is one of the country's outstanding devotees of this branch.

The third chapter, History of Classification, is rather a critical account of the sequence of systems of classification. This is admirably done, but is marred here and there by such things as a misconception about the nature of the Académie des Sciences, of which Adanson was a member (p. 27), and the statement that Lamarck is best known for his *Flore française* (rather than his *Encyclopédie*), etc. The distinction between natural and phylogenetic systems, maintained here and throughout the book, hardly seems valid, as phylogenetic systems are certainly natural.

From Chapter IV, entitled Principles of Taxonomy, through Chapter VIII, the material presented is a mixture of fundamental principles and the basic data on which classifications are founded. Chapter VI is a more or less detailed exposition of most of the current systems of arrangement of the flowering plants. The author nowhere expresses his preference among these, but his extended consideration of the Bessey system, by many regarded as of principally historical interest, and his comment that "there is good reason to believe that an improved and modified Bessey system, expanded to account for the entire plant kingdom will be formulated within the next decade or two," are perhaps indicative. Lawrence nowhere, though, brings out very well Bessey's original and important contribution, which is a methodology of using phylogenetic information in the orderly arrangement of the plant kingdom. Most of the systems in use at present are given some attention, even the newer and less known ones of Tippo and Skottsberg, but one which is sometimes considered the soundest of all, that of J. Burtt Davy, published in preliminary form about 15 years ago, is nowhere mentioned. Its author died before he had finished expanding it into book form, so it has gone unnoticed by many.

The chapter on Principles of Taxonomy not only devotes itself to the principles and philosophy of biological classification and the order and nature of the categories used, but also to an outline of the gross morphology of flowering plants as it is used as a basis for classification. This is a very competent discussion, especially as it brings many recent ideas and lines of evidence into their proper relationship with modern taxonomic thought. The statement, however, that the period of descriptive taxonomy "functioned on a scientific level in the nineteenth century, and only recently has waned and may become secondary in importance" is one which should not be allowed to stand unchallenged. Though it results from the author's emphasis on a supposed distinction between "descriptive" and "modern" taxonomy, it is still misleading. The very size of the task confronting taxonomists and their small numbers make it quite necessary and inevitable that the vast majority of taxonomic work be purely descriptive. There is no questioning of the importance of newer approaches in systematic work, and of their healthy influence on taxonomic thought, but it is still impossible, under the present scheme of things, that descriptive taxonomy could be displaced by these new methodologies. Furthermore, any statement which tends to belittle or lessen enthusiasm for the descriptive work which is the bulk of the activity in the science is unfortunate. This will make students unhappy and bored with much of the work that they will have to do during their careers. It may further result in a plethora of taxonomic treatments that, while very modern, are quite useless in the identification of plants. Such statements are doubly curious when they come from an author whose own work shows no suggestion that he in any way underestimates the importance of descriptive taxonomy.

In the chapter on phylogenetic considerations, the sources and nature of phylogenetic evidence are ably outlined, and its pertinence to classification is explained. Very properly, emphasis is placed on the diversity of phylogenetic concepts and the consequent extremely tentative nature of their present application to a system of plant classification. The varying ideas on the origin and derivation of the angiosperms are described as an example of such diversity. The various theories on this subject, both plausible and unlikely, are presented; and the views of others, rather than the author's own, are generally employed or mentioned to indicate which of these should be rejected. One serious *non-sequitur* has apparently crept in, namely, the statement that "Acceptance of the view that the woody habit preceded the herbaceous demands acceptance also of the view that the angiosperms are a polyphyletic taxon, for, as Sinnott and Bailey pointed out 'it is quite evident that whichever of these two classes [i.e., woody or herbaceous angiosperms] is the more recent it must have arisen quite independently many different times, and from numerous ancient stocks.'" (p. 106).

As noted above, the effects on taxonomic thought of newer approaches to plant classification are profound. For the first time in the history of systematic botany, answers to many questions of "how?" as well as to those of "what?" are becoming available. This is brought about by the use of data from many lines of investigation fomerly not emphasized, or sometimes not even admitted as pertinent in systematic botany. Evidence from distribution, ecology, population structure, genetics, and cytology, as well as the more classical sort from morphology and anatomy has come to be utilized wherever available. The chapters on The Geography of Vascular Plants and Biosystematics and Cytogenetics deal very adequately with much of this kind of information, explaining its nature as well as its application to classification and relationship.

The chapter on distribution includes, as is quite proper, a background in geology. There is little doubt that this would have been improved if submitted for

criticism to a geologist. Certainly a large part of the "few billion years" of the earth's age would then have been placed in something like an Azoic era, before life appeared, rather than the entire history being divided between the five eras from which evidences of life are known. A geographer would have caught the statement that "A study of Fig. 19 shows the earth's surface to be mostly in the northern hemisphere" (p. 147), and a paleobotanist the absence of modern Lycopsida from the chart on p. 146. In general, however, this is a better exposition of the principles of floristic plant geography than may be found in comparable space anywhere else.

One may also recommend the chapter on Biosystematics and Cytogenetics with little reservation, except the obvious one that an adequate treatment of such a field is, to say the least, difficult in 20 pages. The discussion is generally a cautious one, and the limitations as well as the virtues of these approaches are brought out. A curious omission is that no mention is made of modern advances in population studies, which seem to be one of the main approaches of the biosystematists. A description of these techniques, without, however, any reference to their significance in biosystematic studies, may be found on pp. 269–270.

Chapters IX to XIV describe the working procedures, techniques, traditions, and basic materials of standard descriptive systematic botany. The chapters treat Plant Nomenclature, Plant Identification, Field and Herbarium Techniques, Monographs and Revisions, Floristics, and the Literature of Taxonomic Botany. These chapters are so competently written that there is little to be said about them, beyond recommending them as required reading not only for students but for most professional taxonomists. The chapter on nomenclature is certainly the clearest available explanation of this difficult subject. One could point out a few errors, e.g., the definition of *cotype*, but these are minor indeed. In the chapter on identification, in addition to the three methods of plant identification, reference should have been made to identification by comparison in the herbarium, as this is certainly a widely practiced and useful method.

The discussions of monographs, revisions, floras, lists, manuals, etc. will surely help to clear up some of the bewilderment of the student whose professor does not bother to explain these things to him. Chapters XII–XIV could form the basis of a separate, and much needed, course in the botanical literature. Probably nowhere else is there available such a concise, and at the same time, ample survey of botanical literature, at least for American botany, as in the chapter on the literature of taxonomic botany. This, together with the valuable bibliographies found at the ends of most of the chapters in the book, as well as accompanying each family in Part II, provides an admirable foundation for the familiarity with what has been done and written that is one of the basic requirements for competency in systematic botany. The author may also be commended on his brief, yet effective style of literature citation.

Of Part II, Selected Families of Vascular Plants, little more need be said. The basis for the selection is perhaps as good as any, if all families are not to be included. There are brief diagnoses and discussions of the higher categories, descriptions of the families accompanied by short statements of the number of genera and geographic distribution, relationships, and economic members. One of the outstanding features of the book is the quality of the illustrations for every family, mostly drawn by Marion E. Ruff or borrowed from L. H. Bailey's *Manual of Cultivated Plants*, 2nd ed. These provide habit and analytical drawings that should enable anyone to gain some concept of family characteristics, as well as of the diversity of vascular plants.

The question must now be approached; how adequate is this textbook for the teaching of systematic botany?

It may seem to some that there has been, in this review, too much emphasis on the faults of the book. In evaluating a textbook for teaching, a book that thousands of students may be asked or required to purchase, such emphasis is desirable and necessary. The author of a textbook sets himself up to instruct beginners in his profession. His errors and faults thus assume extraordinary significance, as also do his virtues and accomplishments. It would be fortunate, indeed, if the relatively minor faults noted in the discussion of separate sections were the only ones. It must be pointed out, unhappily, that several more general criticisms should be made. Minor errors of fact, slips of the pen, and typographical errors (less than usual) are a common feature of the book. These will undoubtedly be caught in a second edition. A more important trouble is a certain lack of facility with language, especially in the early parts of the book, that is quite disconcerting. Frequently it is quite obvious that the author has not quite said what he intended to say. Also, some parts of the book are much too slow reading for average American university students. This is a reflection rather on the students than on the book, but it is an important consideration, nonetheless. It will probably result in this book being present on every reference shelf, and as collateral reading in every taxonomy course, but in its being a required textbook in relatively few of them. It must be said, however, and emphasized, that any student who masters the contents of this textbook will have the basic knowledge to enable him, given industry, experience, and judgment, to become a highly competent systematic botanist.

The publishers should be urged to provide, for the next edition, an experienced editor with a combination of botanical background and feeling for the English language. Such a person could very readily eliminate all of the outstanding faults of the present edition,

except its comprehensiveness, which is both virtue and fault, and which is inherent in the concept of the work. The price, though high for a textbook, is about what has come to be standard for a book of this size and nature. The binding is good and attractive, and the volume opens out fairly flat.

F. R. FOSBERG

TEXT-BOOK OF MODERN POLLEN ANALYSIS.

By Knut Faegri and Johs. Iversen. Ejnar Munksgaard, Copenhagen, Denmark. $2.75. 168 pp. + 1 folding pl.; text ill. 1950.

Pollen analysis is one of the modern integrative sciences. It attracts the interest of and often requires the skills of sedimentary and glacial geologists, plant ecologists and geographers, hydrobiologists, climatologists, archeologists, and paleontologists. No book of greater importance for pollen analysis has appeared in any language, much less English, than Faegri and Iversen's *Text-book of Modern Pollen Analysis*. It would be greatly to the detriment of the development of the science of pollen analysis in North America if this book were to be overlooked. It is to be hoped that present and potential investigators in pollen analysis and naturalists generally interested in the results of pollen analysis will become familiar with its content and point of view.

The authors have dedicated their book to Lennart von Post (Stockholm), who was their teacher and to them "the grand old man of pollen analysis" who first realized about 35 years ago the potentialities of the science. They also express their indebtedness to Knud Jessen (Copenhagen), whose exactness and common sense in pollen analysis make him one of the science's most important pioneers. But it is the present book by Faegri (of Oslo) and Iversen (of Copenhagen) that marks the maturity of pollen analysis, no small part of which is to be credited to the intelligence and painstaking efforts of the authors' own studies. Other recent students, among whom can be mentioned Firbas, Goodwin, Troels-Smith, Erdtman, Lüdi, Welten, and others, have done much to forward the application of pollen analysis in Europe and to assist in its technical advances; but Faegri and Iversen have brought together in their small book the crux of the matter and have presented it in such a manner that, despite the great difficulties inherent in the subject and the great quantity of uncritical publications in the field, pollen analysis emerges as an important, useful, and interesting science worthy of the attention of fine scientific minds. Although pollen analysis requires a sound botanical basis for its successful prosecution, it is to be hoped that American geologists will develop an interest comparable to that of European geologists, who have done so much to forward the science with mutual profit, and that more investigators here will adopt pollen analysis as their major field. The science has lagged in the United States because students have seldom given it more than peripheral attention: it requires the leadership of at least some full-time investigators.

Faegri and Iversen's *Modern Pollen Analysis* does not summarize extensive regional studies, like Firbas' recent *Waldgeschichte*. It presents concepts, principles, and methods, not results. Naturally enough, the illustrations of principles are drawn mostly from northern European studies. One has to make his own local applications anyway; but the principles are of general import, and there can be no fixed rules for their application in different areas. Although written as a textbook, treating each subject succinctly, the work is valuable not only for beginning students of pollen analysis, but also for more experienced persons. This is true because of the penetrating understanding on the part of the authors of their many-faceted field, and because of their high ability to express themselves precisely in other than their native tongues.

The reader is carried along logically from chapter to chapter in the development of the science. (It is both surprising and gratifying that a book that is so useful as a reference on matters of technique and interpretation *can* be read from cover to cover with growing absorption.) The chapters fall into clear groups. After a brief historical outline, consideration is given to the form and function of the pollen grain (the major object of study), to the production and dispersal of pollen grains, and to peat and other sediment types. Another section consists of chapters on field and laboratory techniques, which are critical for what is to follow, and on the expression of results in pollen diagrams (series of spectra) and fossil forest maps. Finally, there is the most critical section, that which deals with the interpretation of pollen diagrams, sources of error (including a special chapter on statistical errors), pollen analytical zones (or stratigraphic periods), and the applications of pollen analysis. There is a key to pollen classes, a key to northwestern European pollen types, a glossary of morphological terms, a short and well-selected bibliography, and an adequate index.

Thus to epitomize a book, however, does not suggest adequately its true character. Hence, a brief discussion of some of the principal points in pollen analysis, as understood by these leaders in the field, may be useful.

Correctness of identification is obviously critical. Keys, drawings and photographs, and size-frequency data are secondary guides, whereas a collection of reference pollen slides of all pertinent species is an absolute necessity for correct determinations. There should be noted the apparent validity of the assumption that late glacial and postglacial pollen fossils are all directly referable to living species, although not only to those of the contemporaneous flora of a given

region. Further botanical knowledge, specifically a knowledge of the composition, ecology, and dynamics of vegetation, forms an absolute requirement for a stable foundation on which to base pollen analysis. This can be illustrated by the many discussions over *Corylus* in European diagrams. Following von Post, most authors have excluded *Corylus* from the sum of arboreal pollen inasmuch, "as the hazel generally occurs in the shrub layer of the mixed oak forests and under exceptional circumstances only forms separate communities that compete with the other forest types." The authors continue, however, that "unfortunately, von Post's statement is only partly correct, as the hazels of the shrub layer in unthinned forest do not flower or flower very sparsely. The *Corylus* pollen met with in pollen analysis partly represents forest margins, partly specimens forming part of the upper canopy, partly areas where *Corylus* enters into the regular succession cycle of the vegetation. If we want a Northern European pollen sum to give an adequate representation of the composition of the topmost layer of vegetation, *Corylus* cannot be excluded"—although it may have to receive reduced representation.

The establishment of the proper species to be included in the arboreal pollen sum (on a basis of which the percentage of occurrence of individual types is expressed) thus requires a sound knowledge of vegetation. In dealing with vegetational history a proper balance must be developed between arboreal and non-arboreal pollen types. This requires the botanical knowledge to distinguish between local pollen and that portion likely due to long-distance transport, to separate out successional changes from those induced by climatic change, to detect the influences of topography and altitude, to recognize the influence of locations in the vegetational pattern that are produced by the different communities that may occur on, for example, sandy versus clay soils, and to recognize the influences of fire and agriculture. Furthermore, pollen diagrams should be compared with the sequence of sediment types, for a shift, for example, from gyttja or marl to peat may have a strong influence on arboreal as well as on non-arboreal pollen, as when a pine forest develops locally on the peat of a lake margin that has passed from open-water deposition through a bog succession. Within the sum of arboreal pollen there also arise questions as to over- and under-representation, not only according to specific differences in pollen production, but also according to stand density, closed- versus open-forest, and forest-border conditions. These are indeed often tricky questions for one not well grounded in a knowledge of the ecology and geography of the types of vegetation involved in the diagrams being studied.

Pollen analysis is, of course, palaeofloristic in the usual sense, but it has an important advantage over studies of seeds, leaves, wood, cone-scales, etc., in that all pollen grains are strictly comparable and their relative frequency can be expressed as percentages of the whole. This being true, variations in percentages from one stratigraphic level to the next take on real significance. Changes in specific and generic percentages, and in ecologically related groups (such as *Ulmus*, *Tilia*, *Quercus*, and *Fraxinus* in the mixed-oak forests of Northern Europe) can be taken to represent changes in the dominant, and perhaps the climax, vegetation of the area. Pollen diagrams represent vegetation and nothing else, not climate, nor soil, nor topography. A diagram must be translated into vegetation, the authors emphasize, before one seeks reasons for the changes that have been discovered. When working in an area, it is important to establish a "normal diagram" for the area with which abnormalities, such as those induced by erosion surfaces, redeposition, or other peculiar local conditions, can be compared. A single diagram from an area, however "good," is greatly strengthened by comparison with other diagrams because of the principle of regional parallelism. Climatic changes will show in more than one area, although the effects are often different. Here again ecological knowledge becomes basic. Pollen diagram curves are not, of course, independent phenomena. Their interpretation must always be made in relation to what is happening to the curves for other pollen types. Also, the actual numbers of pollen grains that are identified and counted to form a spectrum are relative, not absolute. For example, oak with pine may have a relatively low percentage, whereas relative to beech the same quantity of oak may have a value increased several fold.

Faegri and Iversen emphasize the major sources of error in pollen analysis and review such information as exists regarding how to minimize or obviate such errors. Errors due to undetected erosion contacts and to redeposition of sediments can often be eliminated by study of a profile of the sediments, rather than a single diagram. The differential destruction of pollen species can often be detected by obvious corrosion of exines of incompletely destroyed grains. Such samples should be avoided or treated with great caution. Local over-representation of some heavy pollen producer, such as pine on the peat of the sedimentary basin, can be expected to result from a strong change in pollen percentages that parallels a change in sediment types. This danger is greater, of course, in non-arboreal pollen. Finally, long-distance transport is usually a subordinate factor, but it can be critical. It is important, for example, in determining the immigration or the local extinction of a species. Far-transported arboreal pollen in a forested region has relatively slight importance in the percentages of the spectra, but in a thinly or non-forested region it may be wholly misleading. Such are the vicissitudes faced by the pollen analyst.

Iversen, Faegri, and a few others have refined pollen analytical studies by counting much larger numbers of grains than is customary. The reason for counting

several hundred grains from a sample, and sometimes as many as a thousand or two thousand, is to refine the curves for the rarer species of pollen, both arboreal and non-arboreal, and to bring out their significance, which is often greater than that of the dominating arboreal pollen. In the same spirit of extracting the last iota of significance from pollen spectra, such investigators have paid special attention to the identification of the rarer fossils, often with illuminating results showing the early influence of man, for example. Given good optical equipment, keen observation, and much patience, distinctive details of the structure of the ektexine have been revealed that were formerly unsuspected. Faegri and Iversen's chapter on The Pollen Grain, its Form and Function summarizes such results. Attention should be called, however, to a later publication by Iversen and Troels-Smith (see Iversen, Johs., and J. Troels-Smith. 1950. Pollenmorfologiske definitioner og typer, 54 pp., 16 plates. *Danmarks Geol. Undersog.* IV Raekke, Bd. 3., No. 8. Copenhagen. (Also in German)) which presents the matter in greater detail.

STANLEY A. CAIN

GRASSES OF WISCONSIN. *The Taxonomy, Ecology, and Distribution of the Gramineae Growing in the State without Cultivation. With An Essay, The Vegetation of Wisconsin, by John T. Curtis.*

By Norman C. Fassett. The University of Wisconsin Press, Masdion. $3.00. viii + 174 pp.; text ill. 1951.

The scope of this book is stated in the Introduction as a treatment of (1) the wild, native grasses, (2) those which have escaped from cultivation and are collected frequently, and finally, (3) those grasses which have been introduced into Wisconsin from other areas. The nomenclature is based on Hitchcock's *Manual of Grasses* (1935) and on the eighth edition of Gray's *Manual*. The use of range maps is discussed and the method employed in this treatment is described. The amateur is warned that he must know the morphological terminology used in grass taxonomy before he attempts identification. A very lucid account of spikelet morphology is provided; the terms are italicized and the reader is referred to figures which illustrate the morphological structure under discussion. Reference is made to the use of vegetative characters in grass taxonomy, but floral characters are used almost exclusively in the *Grasses of Wisconsin*.

A key to the 2 subfamilies and 10 tribes follows the Introduction. The characters set forth in this key have references to figures illustrating that particular morphological character, e. g., "*a.* Spikelets more or less compressed dorsally (Figs. 283, 289, 296, 332, 348), . . .".

The grasses are treated in detail under the title Characteristics and Distribution of the Gramineae of Wisconsin. Each tribe is treated separately, with a key to its genera; each genus in that tribe has a key to its species; and this is followed by a discussion of the species, its varieties and forms, or both. For some species, a key to its varieties and forms is given, e. g., *Agropyron repens* and *A. trachycaulum*. Common names are included occasionally, but it is good to see that they are not emphasized. 64 genera and 188 species in 10 tribes are included in this section.

Fassett follows Shinners and Pohl in his treatment of the 23 species and varieties of *Panicum*. On the basis of spikelet measurements, many species in the *Lanuginosa*, *Oligosantha*, and *Columbiana* groups are lumped. It is stated (p. 84) that "*Leptoloma cognatum* is sometimes confused with *Panicum capillare*; . . ." The spikelets of these two grasses are quite distinct, in addition to the vegetative characters listed by Fassett for distinguishing *P. capillare* from *Leptoloma cognatum*. *Panicum* is a large and difficult genus and it is not surprising to find 12 cases listed at the end of the treatment on *Panicum* which cannot be assigned satisfactorily to species.

Following this section on the Gramineae, there is a brief account of the Geology of Michigan and a discussion of The Vegetation of Wisconsin, by John T Curtis (pp. 97–102).

All 356 figures are placed together at the end. The usefulness of the book is reduced by this technique, but is was undoubtedly done to save printing costs. Most of the illustrations are taken from Hitchcock's *Manuel of Grasses* (1935) with the addition of labels to indicate specific morphological structures.

Seventy terms and abbreviations are listed in the glossary. Nearly every definition refers the reader to one or more figures which serve to illustrate the term defined. There is a general index to the volume. The *Grasses of Wisconsin* is well organized, carefully prepared, and very easy to use. It should be of great value to everyone interested in Wisconsin grasses, and it should be very useful in beginning courses in the taxonomy of grasses. The *Grasses of Wisconsin* will encourage the amateur as well as the botany student to learn more about one of the most important families of flowering plants.

ERNEST R. SOHNS

THE ILLUSTRATED ENCYCLOPEDIA OF AMERICAN WILD FLOWERS.

By Ethel Hinckley Hausman; illustrated by Tabea Hofmann and the author. Garden City Publishing Company, Garden City, New York. $2.49. lxxii + 534 pp. + 16 pl.; text ill. 1947.

This encyclopedia is designed as a reference book for

amateur botanists who wish to become acquainted with the common wild flowers of the United States. It contains notes on 1200 of what the author considers the "most representative flowers of all parts of the country." They represent 87 families. In a brief introduction there is a statement of the purpose of the book, a discussion of the "names of plants," and some information on how to use the book. The encyclopedia itself is prefaced by an "Illustrated Guide to the Flower Families." Here the families are given general descriptions, and each is illustrated with a line drawing of one or more species which characterize it.

The encyclopedia is in alphabetical sequence, and is based upon common names alone. As would be expected, much of it is devoted to the cross-referencing of the common names. Wherever the name of a family, such as the "Barberry Family" (p. 10), appears, the common flowers within this family are then described, and many of them are illustrated with line drawings. Along with the descriptions are given notes on habitat, period of bloom, and general distribution in the United States. Following the encyclopedia is a partially illustrated glossary containing 69 text figures, and a series of regional wild flower protection lists. There is also a list of the floral emblems of the states and of the Canadian Provinces. In addition to the line drawings, there are 16 full-page colored plates showing assemblages of common wild flowers in various habitats.

For the purpose to which the book is devoted, it leaves a good deal to be desired. The idea of the illustrated family descriptions at the beginning is a good one, but it lacks the essential element that would have made it useful. This would be a simple key, based upon characters that can be seen easily by anyone, and many of which are already drawn into the illustrations. By sublimating latin names in favor of vernacular ones, the author has taken leave of an excellent mechanism of consistency, and has opened the encyclopedia to endless and unnecessary confusion of names. In the descriptions latin names (a surprising number of them misspelled) are given in parenthesis after the accepted common names. A great many of the latin names are out-of-date in terms of modern taxonomic work, and will lead to much further confusion for the amateur who really wishes to learn the names of the plants.

The book illustrates an unfortunate tendency on the part of many writers of popular treatises on flora and fauna. It is assumed that the beginning amateur is incapable of using, or at least is completely unwilling to use, existing and well-known technical aids for the identification of plants or animals. Having by-passed the only standard nomenclature available, and having eliminated the usual forms of key, these authors proceed to invent new schemes for identification that usually turn out to be far more confusing and unworkable than the methods they have tried so hard to avoid. So far as nomenclature is concerned, it would be difficult to conceive of anything more confusing than the maze of common names through which the author of the present volume tries to find her way. The classification and nomenclature of plants have had a long and laborious evolutionary history in the minds of men. Although it is far from perfect, systematists have come up with a usable scheme of relationships among the flowering plants; and they have invented a simple system of naming plants which has been thoroughly tried and found to be workable. This book and many others would be far better if their authors had expended their time and energy on making existing keys and standard nomenclature more readily usable to beginners.

H. M. RAUP

ARIZONA FLORA.

By Thomas H. Kearney, Robert H. Peebles, and collaborators. University of California Press, Berkeley. $7.50. viii + 1032 pp. + 33 pl. 1951.

Ten years ago there appeared the *Flowering Plants and Ferns of Arizona*, by Thomas H. Kearney and Robert H. Peebles, a major event in the history of our knowledge of the botany of the arid southwestern United States. This publication crowned a lifetime of work on the flora of Arizona, especially by the senior author, whose first publication on the plants of Arizona appeared in 1895. Most men would have been content with such a monument and would have settled back to enjoy a well-earned rest. But not so Kearney. The ink was scarcely dry on this book before he was busily working on a revision.

After 10 years of as diligent work as though he were not retired, Kearney, again with the aid of Peebles and almost the same group of collaborators, has produced the *Arizona Flora*, basically a revision of its predecessor, but so amplified and improved as to deserve well to be regarded as a new work and to merit its new title. Surely this work is so nearly a definitive one that it will be many years before another flora of Arizona appears.

According to the author's figures, 1 family, 32 genera, and 190 species have been added to the known flora of the state, and much more information has become available on the distribution of the species already known. With this in mind, it is surprising, on first examination, that the new book has only 1032 pages, compared to its predecessor's 1069. Closer examination reveals by what economies this reduction, rather than the expected increase, has been accomplished. The lines are very slightly longer, though the page size is not significantly larger. The keys, many of them rewritten, have been changed from the indented style to the space-saving, but less convenient, bracket style. The lists of synonyms, with bibliographic references, one of the most useful features of the 1942 book, have been omitted

and replaced by inclusion of a few of the more important synonyms, without bibliographic references, in parentheses in the text following the accepted name. References to the original publications of the accepted names are also omitted, and these names, in bold face, start the paragraphs of text treating the species, rather than being given separate lines, as in the previous work. Occasionally, as in the treatment of the varieties of *Silene scouleri* Hook., even the authors of the names are omitted. It is, of course, clear that these economies were necessary to keep the price within reason, and probably, indeed, to secure publication in these illogical days when investigations are supported lavishly while publications is usually left to depend on what the prospective user can squeeze from his own pocketbook. This should not, however, obscure the fact that such economies reduce the usefulness of the book, and that the increased time spent in using it will much more than offset the cost of a few additional pages. Such considerations are important in a period when the time of scientifically trained persons seems to be at a premium. However, the University of California Press is to be congratulated in keeping the price of the book at a low figure compared to that of other contemporary books of comparable importance and substantially smaller size.

One also may regret the decision to reduce the treatment of the vegetation of the state, done in the previous volume by Forrest Shreve, to a condensed summary, accompanied by valuable notes on the physical environment. But Shreve's treatment is, after all, available in the earlier work to those who really need it.

A section containing 47 well reproduced photographs contributed by Robert H. Peebles, is one of the most attractive features of the book. The majority of them are of cacti, a group of plants of which Arizona can boast the most spectacular assortment to be found in the United States; but a number of plants of other families are represented, along with a few landscapes showing characteristic vegetation types. A beautiful colored frontispiece of *Sphaeralcea*, a genus on which Kearney is the principal authority, introduces the work.

Examination of the taxonomic treatments in various genera shows that the authors have been aware of and have benefitted by the large number of revisions, monographs, and smaller papers that have appeared in the intervening years. It also shows that these have been followed neither slavishly nor uncritically. The general point of view is conservative, though the acceptance of finely segregated genera in the dryopteroid ferns, the Cactaceae, and some other families, is an exception to this. Where the authors' treatment of various genera have been influenced by recent monographs and revisions, these are referred to by number, as listed in the extensive bibliography which follows the main text of the book. The treatments of some of the more critical groups of plants, including such extensive families as the Gramineae and the Compositeae, are contributed by the recognized specialists, and hence reflect the viewpoints of these workers rather than that of the authors of the flora.

An excellent glossary and index, as well as the bibliography of 371 references, are provided. The typography is attractive and easily read, and the book seems well bound and opens out flat.

This book should stimulate an even greater interest in the plant life of this wonderful state than did its worthy predecessor. Kearney should indeed regard with great satisfaction this second crowning achievement of his 60 years interest in the botany of Arizona. In all probability, however, our next visit to the herbarium of the California Academy of Science will find him enthusiastically engaged in a revision of this magnificent work.

F. R. FOSBERG

TREES AND SHRUBS *in Eastern North America. Keys to the Wild and Cultivated Woody Plants Growing in the Temperate Regions Exclusive of Conifers.*

By Benjamin Blackburn. Oxford University Press, New York. $6.00. xvi + 357 pp.; ill. 1952.

The usual book of this kind generally deals either with native species or with those of selected ornamental value. A great host of other woody species, however, have entered this country during the past few centuries, naturalized themselves, and almost lost their identity as introduced forms. From Maryland southward, the empress-tree, the chinaberry, and the crepe myrtle are such conspicuous and successful elements as to warrant membership in a floral D. A. R.; the European barberry to the north falls into the same category. Our flora has, as a consequence, been enriched as the centuries have gone by, and, like our population, is of a polyglot character. The author, therefore, has written this volume with the idea that the user is unfamiliar with the native homes of most plants, and consequently does not know whether to turn to a book of native species or to one dealing with ornamentals in seeking the identity of a particular plant. The result, from a general check on the usefulness of the keys, is a happy one, for the commoner woody species readily yield their identity. Some readers may object to the absence of illustrations for confirmatory evidence, but except where fine details are necessary for tracking down a species, illustrations are more apt to be an impediment than an aid. This is a handy volume which fills a neglected niche in a library of natural history.

C. P. SWANSON

ILLUSTRATED GUIDE TO TREES AND SHRUBS. *A Guide to the Woody Plants of the Northeastern United States—*

Native, Naturalized and Commonly Cultivated Exotic Kinds, Including both Summer and Winter Characters. *By Arthur Harmount Graves. Published by the Author, Wallingford, Connecticut.* $4.00. x + 240 pp.; ill. 1952.

The usual book of this sort deals either with native materials in a botanical sense, or with ornamentals of horticultural value. The overlap in coverage is partial, and, because of intent, generally accidental, with the result that it is often difficult to identify many plants which come under neither category. The author has attempted to bridge the gap with a coverage that includes the New England states, New York, Pennsylvania, New Jersey, and Delaware. The result is a useful manual for those who wish merely an identification of some of the commoner woody forms generally encountered. A key, based for the most part on leaf and stem characters, will prove of aid, as will the line drawings. Some descriptions are abbreviated, however, almost to the point of uselessness, and will lead to confusion and a degree of frustration.

C. P. SWANSON

A DICTIONARY OF BOTANICAL TERMS.

By Blodwen Lloyd. University of London Press, London. 12s. 6d. ii + 64 pp.; ill. 1950.

The obstacle of terminology is one of the greatest of hurdles for the beginning student in botany, and particularly so with the virtual absence of classical Latin and Greek from the lower curriculums. As an aid to such students, the author has compiled a dictionary of approximately a thousand botanical terms commonly encountered in elementary courses. In general, the definitions are satisfactory, although occasionally in searching for the root of a group of similar words, one runs around in a circle without coming to a definitive meaning except in terms of something else equally elusive. This might have been overcome by a brief listing of the commoner roots. Where difficulty is met with in conveying meaning, however, line drawings are made use of with good effect. This is strictly a utilitarian book.

C. P. SWANSON

PLANT PHYSIOLOGY

ANNUAL REVIEW OF PLANT PHYSIOLOGY. *Volume 3. Edited by Daniel I. Arnon and Leonard Machlis. Annual Reviews, Stanford, California.* $6.00. x + 369 pp. 1952.

This annual review continues to be the single most useful compendium in the field of plant physiology. The high quality of the articles noted in the previous volume (*Q. R. B.*, 27: 89. 1952) has been maintained, and the diversity of subjects reviewed is, if anything, even broader than in past issues.

The main criticism that one may continue to make lies in the rather limited geographical distribution of the authors, for of the 15 articles, 11 are written by residents of the United States, and only one each by residents of England, Germany, Netherlands, and Australia. Once again, of the 16 American authors, 11 are Californians, showing that the editors understandably prefer to look close to home for their talent, rather than further afield. Such loyalty to local pundits may be understandable, but is perhaps not best calculated to produce universality of approach or real coverage of the literature.

The subjects reviewed demonstrate the increasing importance of the biochemical approach to the solution of classical problems of plant physiology. Ten years ago, it would have been impossible to write a sizeable review on the subject of glycolytic enzymes, carboxylating enzymes, the metabolism of phosphorylated compounds, leaf proteins, or the biochemistry of hormone action in plants. In the present volume, each of these topics is covered by a sizeable article, replete with a bulging bibliography. This trend toward the biochemicalization of plant physiology may be expected to continue, at least until the cultural gap between animal and plant biochemistry has been somewhat narrowed.

The subjects reviewed and the authors of each article are as follows: Factors Affecting Availability of Inorganic Nutrients in Soils With Special Reference to Micro-Nutrient Metals (G. W. Leeper); Glycolytic Enzymes in Higher Plants (P. K. Stumpf); Metabolism of Phosphorylated Compounds in Plants (H. Albaum); Studies of the Physiology, Pharmacology, and Biochemistry of the Auxins (J. Bonner and R. S. Bandurski); Agricultural Application of Growth Regulators and Their Physiological Basis (J. van Overbeek); Transport of Organic Compounds (W. H. Arisz); Leaf Proteins (S. Wildman and A Jagendorf); Physiological Aspects of Low Temperature Preservation of Plant Products (M. A. Joslyn and H. C. Diehl); Physiology of Virus Diseases (F. C. Bawden and N. W. Pirie); Mechanisms of Ion Absorption by Roots (R. Overstreet and L. Jacobson); Physiological Bases for Assessing the Nutritional Requirements of Plants (A. Ulrich); Photosynthesis (E. Rabinowitch); Physiology of Flowering (A. Lang); Carboxylating Enzymes in Plants (B. Vennesland and E. E. Conn); and Tree Physiology (B. Huber).

ARTHUR W. GALSTON

PRINCIPLES OF PLANT PHYSIOLOGY.

By James Bonner and Arthur W. Galston; illustrations by Evan L. Gillespie. W. H. Freeman & Company, San Francisco. $5.50. x + 499 pp.; ill. 1952.

The teaching of plant physiology has suffered from a number of ills during recent years, not the least of which has been the lack of a satisfactory textbook for adequately presenting the subject to elementary students in terms of modern chemical and biochemical thinking. This new textbook by James Bonner and Arthur W. Galston should materially remedy the situation. The authors have very ably written a textbook that will be extremely useful in introducing elementary plant physiology to students in either the applied or general teaching fields. An attractive feature of the book is the set of original illustrations which highlight and emphasize the various topics discussed.

The subject matter is divided into three sections: Nutrition; Metabolism; and Growth and Development. The nutrition section considers the problems of photosynthesis, the absorption and translocation of water and nutrient ions, the function of the nutrient ions, and the role of the soil in plant growth. The section on metabolism deals, in terms of modern biochemical knowledge, with plant enzyme systems, respiration, and the metabolic roles of carbohydrates, proteins, and lipids. This section is concluded with an informative chapter, entitled Highways and Byways in Plant Metabolism, which discusses the alkaloids essential oils, pigments, rubber, and other comparatively little studied plant constituents. The last section, on growth and development, is, in my opinion, one of the finest presentations that have appeared on this important phase of plant physiology. In this section are discussed the dynamics of growth and development, the auxin problem, and the physiology of reproduction, differentiation, and dormancy. Each chapter contains a brief summary and a list of questions that point up the salient features of the chapter. Detailed original literature citations are not included, but each chapter contains a brief list of general reading references.

For the sake of brevity the authors have avoided detailed discussions of many controversial and contradictory subjects. For the most part, this viewpoint has led to the integration of these subjects into single hypotheses that, in the opinion of the writers, best explain the situation. I feel, however, that not all plant physiologists will agree with the authors as to how these controversial matters should be interpreted. In the hands of an experienced teacher of plant physiology, the students can be made aware of the significance and nature of these contradictory viewpoints. In less experienced hands, students may get the idea that a considerable number of really critical problems have been settled. This onesidedness, however, does not detract from the many really worth-while features of the book.

G. R. NOGGLE

DIE WUCHSSTOFFLEHRE. *Ergebnisse und Probleme der Wuchsstofforschung.*

By Hans Söding. Georg Thieme Verlag, Stuttgart; [Grune & Stratton, New York]. DM. 33.00. xii + 304 pp.; ill. 1952.

This book on plant growth substances, or auxins, by one who has worked on the subject since 1923, is of the greatest interest. It contains a great deal of experimental data, and is of course especially rich in references to the European literature; but American papers are cited too, and up to 1949. Although it is written throughout in a clear and straightforward style, the author apologizes at the outset for its not being particularly easy reading, saying that the unavoidable fact is that the field is complex and full of unsolved problems.

The opening chapters described methods of extracting auxin from plants and determining it by bioassay. They include a very useful description of Söding's method of carrying out the *Avena* curvature test in daylight. This of course greatly simplifies the procedure of this well-known test. The seedlings are grown in ordinary flower-pots with paper shields, and all the procedures is carried out in the laboratory. There seems no reason why some laboratories should not adopt this, at least for rough work, although with American standards of central heating the maintenance of sufficient humidity might turn out to be difficult. Söding is in general not one to use complex equipment where simpler material will do, and he once said, after hearing all the details of the air-conditioned dark-rooms generally used in American laboratories, "My experimental set-up consists primarily of—one table."

As was inevitable, the chemical nature of the "natural" auxin comes up as soon as chemical matters are introduced. Here we realize with a shock that the author believes that auxin *a* must be "the actual growth substance of higher plants," and that indoleacetic acid is only an "activator" of this substance. This view not only rests on the work of Kögl and his collaborators, but is also supported by the more recent experiments of von Guttenberg, in which auxin which has diffused out of coleoptile tips is found to behave very differently from indole-acetic acid. But this surely is to be expected, since the diffusate includes enzymes from the cut surface, as well as organic acids and other materials diffusing out of the tissue. Biology is full of instances where purified substances have turned out to have different properties from those of the

crude extracts in which they were first detected. Furthermore, Söding readily admits that there is evidence against the view, and describes carefully the different lengths of the curved zones of coleoptiles caused by different auxins, which show that all travel at different rates; if they all activated auxin *a*, the curves zones should be the same. For this and many other reasons, few, if any, present-day workers would accept such a second-hand role for indole-acetic acid in controlling plant growth. Yet the concept, though fundamental, scarcely interferes with the presentation of the subject in most of its aspects, and we can read on without paying further attention to our mental reservations.

There is a very good treatment of auxin production from leafy shoots, flowers, etc., as determined by the "diffusion" method, and the important point is made that the principle of this is not really diffusion at all, but active movement ("*Nachschub*") of auxin into the agar. The remainder of the first 6 chapters follows more or less the lines laid down in earlier books on the subject: effects of treating plants with auxin; effects of genetic and external factors on auxin production; relation between auxin and growth, transport, etc. As far as auxin transport is concerned, one may conclude that while the process is still obscure, so also is the transport of other organic substances in plants, even though known and studied for a much longer time. Auxin transport differs from these mainly by its polarity, and Söding points out that there must be some kind of polar process, or perhaps polar find structure, as yet unknown.

The analysis of auxin action naturally occupies a prominent place. His own detailed knowledge and important contributions enable the author to give a critical and clear description of the extensive early work on cell-wall elasticity and stretching. The later biochemical work, especially that from American laboratories, is, however, also presented very objectively and fairly. In reviewing all the work on auxin action, Söding concludes that the concept of a "growth-respiration," catalyzed by auxin and leading indirectly to all types of growth phenomena, is very doubtful, and hazards the suggestion that the auxin-catalyzed reaction gives rise to a second substance, which causes some general reaction in the plasm;—auxin would thus be a "regulator of a regulator." While there is no harm in such speculation, I would like to suggest that here, as in other connections, Occam's "razor" needs restropping, and that we could well apply its sharp edge to the loose ends of some of our biological theories. The conclusion that more work is needed will, however, be generally accepted.

The other chapters of the book cover tropisms, cell division, correlative inhibitions, and the role of "Wirkstoffen" such as vitamins, wound substances, etc., and their interaction in various growth phenomena. These are good treatments of fields to which Söding has made more than one important contribution, but beyond bringing the literature up to date, they add little really new in ideas. The best parts of the book are the closing paragraphs of several of the chapters and sections, where the author summarizes either the data or his own reaction to them. There are many suggestions here, and if no striking new theories are put forward, still the thoughtful comments are very good, and the area of ignorance is often clearly outlined.

It is unfortunate that few of our students will have the linguistic facility to work their way through more than a few sections of this careful, modest, and thorough review. In any event it should be in the libraries for consultation, and where researches in the more botanical aspects of "auxin-lore" are planned, it should be required reading.

KENNETH V. THIMANN

THE ACTION OF HORMONES ON PLANTS AND INVERTEBRATES. *Reprinted with Additions and Supplementary Bibliographies, from "The Hormones," Volume I. Edited by Kenneth V. Thimann. Academic Press, New York.* $5.80. viii + 228 pp.; ill. 1952.

The first 78 pages, by Thimann, are on auxins in higher plants: assay methods, chemistry, and transport; also on the role of auxin in tropisms and root formation, and in the inhibition of buds, roots, and leaf abscission; and finally, its role in cell division, and such evidence as there is for its mechanism of physiological action. Most of the subject matter will be familiar to those working in the field, but Thimann's point of view is always interesting. The text is based chiefly on selected references from the literature of the early '30s, on through 1946 and early 1947, and an addendum of supplementary references is included through 1950.

The second chapter (pp. 78–123) also by Thimann, deals with other hormones in higher plants, e.g., those of wounds, flower-forming, and leaf growth, also with postulated hormones, and with vitamins, steroids, and carotenoids as plant hormones. The last section includes hormones in fungi. Concluding the chapter is an addendum of supplementary references through 1950. The author is circumspect in his handling of each of the several subjects in Chapter 2. The nature of his conclusions is, in a sense, best expressed in his comment on the problem of leaf growth substances: "Thus the whole problem remains in a suggestive, rather than convincing, state."

The chapter on hormones in insects, by Scharrer (pp. 125–167), considers the endocrine control of post-embryonic development, the role of hormones in reproduction, color change, "gene hormones," and sources of insect hormones; also included is a discussion of their mode of physiological action, and their physico-

chemical properties. A 7-page addendum brings the text digest of the literature up to 1950.

Brown's chapter on crustaceans (pp. 171–214) discusses hormones and sex characteristics, color changes, retinal pigment movements, molting and growth, and a final section on hormones and other activities, e.g., viability, heart rate, blood sugar, etc. Also included is an addendum to the text which carries it through 1950 and early 1951.

The book will be a convenient-sized ready reference work for the shelf of the specialist and the interested graduate student.

GEORGE S. AVERY, JR.

PLANT GROWTH SUBSTANCES.

Edited by Folke Skoog. University of Wisconsin Press, Madison. $6.00. xiv + 476 pp. + 22 pl.; text ill. 1951.

This volume is a collection of papers pertaining to the physiology, biochemistry, chemistry, and agricultural uses of growth substances given in general meetings and round table discussions in September 1949 at the University of Wisconsin. The book makes an attempt to assemble and integrate the present-day knowledge of growth substances by bringing together some of the most prominent workers in the field.

Accordingly, the volume is made up of 39 papers organized under 8 rather general sections. The introductory section, which is more or less a survey of the entire field, includes papers by A. J. Haagen-Smit, K. V. Thimann, T. Kerr, H. Burstrom, A. F. Blakeslee F. W. Went, and P. W. Zimmerman on such varied topics as the history and nature of plant growth hormones, the synthetic auxins, growth and structure of the primary cell wall, mechanisms of cell elongation, control of evolution and life processes in plants, and plant hormones in practice.

The second section is made up of papers dealing with growth substances in plant metabolism. Articles by R. H. Burris, K. V. Thimann, W. D. Bonner, Jr., G. S. Christiansen, G. S. Avery, Jr., and F. G. Smith deal with the connections of growth substances to plant respiration and composition.

The next section covers tissue responses to growth substances and is made up of articles on the relationship of electrical polarity and auxins, translocation of growth-regulating substances and their effect on tissue composition, histological responses to growth-regulating substances, comparative effects of growth substances on stem anatomy, and the formative effect of hormone-like growth regulators. The contributors to this section are A. R. Schrank, J. W. Mitchell, J. M. Beal, B. E. Struckmeyer, and P. W. Zimmerman.

The fourth group of papers is devoted to the practical application of growth regulators and includes chapters by K. C. Barrons, R. S. Dunham, F. E. Gardner, and J. van Overbeek dealing with vegetation control, differential responses in crop plants fruit production, and uses in tropical agriculture.

The next two sections deal with the effect of growth substances in vegetative development and reproductive development, respectively. They are made up of discussions on the role of growth substances in vegetative development as exemplified in tissue cultures, factors influencing the growth of plant embryos, growth substances and the formation of buds in plant tissues, the development of stems and leaves, chemical regulation of sexual processes in fungi, sexual substances of algae, and the relationship of growth substances to flowering and fruiting. The authors of the above articles are P. R. White, N. K. Ziebur, F. Skoog, C. Tsui, F. W. Went, J. R. Raper, G. M. Smith, A. E. Murneek, R. H. Roberts, F. G. Gustafson, R. M. Muri, and S. H. Wittwer.

The last two groups of discussions deal with growth substances in pathological growth, and with vitamins and amino acids as growth factors. The former covers articles by R. S. deRopp, A. C. Hildebrandt, A. J. Riker and J. E. Thomas, T. C. Allen, and E. H. Newcomb. The latter group is comprised of some very interesting chapters by E. E. Snell on growth factors in bacterial nutrition, E. L. Tatum on the genetic aspects of growth responses in fungi, and W. J. Robbins on vitamin and amino acid requirements for the growth of higher plants.

The main contribution of this volume has been to present in one book, in an interesting and stimulating manner, the present state of knowledge of the plant growth substances. The work could have served also as a good reference source for the field, except for the fact that it lacks both subject and author indices.

ALVIN NASON

ECONOMIC BOTANY

ECONOMIC BOTANY. *A Textbook of Useful Plants and Plant Products. Second Edition.*

By Albert F. Hill. McGraw-Hill Company: New York, Toronto, and London. $7.00. xii + 560 pp.; ill. 1952.

World War II forced upon us the realization that the United States, as a nation, is not wholly self-sufficient, and that in times of dire need many of the commonly accepted substances are likely to be in short supply. During periods of international strife, the sources of such substances are oftentimes inaccessible or greatly restricted. Rubber and cinchona furnished good examples of shortages brought about either by enemy action or by an enlarged demand. Such shortages can sometimes be met by the development of synthetic products—rubber again serves to illustrate the point—

or by the exploitation of new sources as well as new products of equivalent value. Many of these strategic materials are of botanical origin, a source which results in the mobilization of botanists to explore untapped resources of fibers, oils, rubber, and insecticides. The role of antibiotics was also being developed during the war period, and the economic botanist found himself pushed into the vanguard of a group of scientific explorers. As a consequence, many relatively unknown plants assumed a role of critical importance because of the products which they could yield. Although, since the war, many of these species have returned to their former position of economic insignificance, the backlog of information gained will once again serve its purpose should the need ever arise in the future.

There is, therefore, good reason for a second edition of Hill's well-known and widely accepted textbook on the economic plants of the world. Like the earlier edition, it is a mine of information on plant products not only as they affect our economy today, but as they have been of importance and interest in the historical past.

C. P. SWANSON

FORAGES. *The Science of Grassland Agriculture. Under the editorial authorship of H. D. Hughes, Maurice E. Heath, and Darrel S. Metcalfe. Iowa State College Press, Ames.* $6.75. xii + 724 pp.; ill. 1951.

This well printed and well illustrated book will prove useful to many persons interested in the general field of grassland agriculture. It was prepared both as a textbook and as a reference book. By the nature of its authorship and by the scope of its subject matter, it appears to fulfil the latter objective better than the former.

The book is distinguished by the breadth and authority of its 55 authors. The inclusion of so many has led unquestionably to a more complete and penetrating coverage of subject matter than would have been possible with one or a few persons as sole authors. Such a procedure has in turn detracted from the book's straight-forward readability as a text. The editors have attempted to unify "the style of organization and presentation," but this was wellnigh impossible task with 55 authors. If more unity had been achieved, the book would have lost character as a reference work.

The editors point out that more material is included in the 60 chapters than can be utilized in most courses on grasslands. They suggest a selection based upon regional interests, but this may result in a coverage too narrow even for the usual one semester course. In many respects the book may be better adapted to advanced courses, special seminar-type courses, or general reference use. Most of the authors have supplemented the text generously with the most pertinent literature citations. For students wishing to pursue particular topics, these citations should constitute a good beginning bibliography.

The many illustrations are excellently reproduced on good paper. Their legends, which consist mainly of detailed quotations from the text, represent tiresome duplication and waste of space. Most of the figures are well selected, although some tend to be generally pictorial rather than specifically illustrative.

The contents are divided into 4 main parts: Forages and a Productive Agriculture (82 pp.); Forage Grasses and Legumes (342 pp.); Forage Production Practices (108 pp.); and Forage Utilization (158 pp.). Here again a rigorous selection might be practiced for teaching purposes. The coverage of the extensive field of grasslands with its many ramifications is excellent, but some phases of the book definitely overlap from basic agronomy into special fields such as breeding, feeding, conservation, and engineering, that may be covered in allied courses. The book concludes with an excellent appendix on Terminology, as well as very complete Author and Subject Indexes.

SANFORD S. ATWOOD

REGISTER OF NEW FRUIT AND NUT VARIETIES, *1920–1950.*

By Reid M. Brooks and H. P. Olmo, with the assistance of cooperating horticulturists. University of California Press, Berkeley and Los Angeles. $3.00. viii + 206 pp 1952.

This book makes available for the first time accurate information in regard to the most important fruit and nut varieties that have originated in North America in recent years, some 1106 in all.

The fruits and nuts are arranged alphabetically. For each variety the correct varietal name, with synonyms, the originator's name and address, date of commercial introduction, plant patent number and name of patentee, date, trademark name, parentage, and the most valuable characteristics are given.

A list of patented varieties a geographic list by place of origin, and an index are appended. The book should prove useful to plant breeders as well as to growers and professional horticulturists.

ALBERT F. HILL

MEDICAL BOTANY. *A Hand-book for Medical Men and All who are Concerned in the Use of Plants: Nutritionists, Dieticians, Pharmacists and Veterinarians. By Alexander Nelson. E. & S. Livingstone, Edinburgh; [Williams & Wilkins Co., Baltimore].* 30s.; $6.50. xii + 544 pp. + 16 pl.; text ill. 1951.

The title of this interesting book is somewhat misleading, since it gives the impression that it is concerned primarily with medicinal plants. As a matter of fact, a better title would be "Food and Drug Plants," for the book is actually a valuable reference work in both of those fields of economic botany. The information presented does indicate the relationship of botany to both human and veterinary medicine, but also points out how plants affect our health and well-being and the part they play in our every-day life. The book should be particularly valuable for dieticians and students of nutrition. Many practical questions are answered, and an unusual amount of data regarding the vitamin content and nutritive value of individual foods is given.

The first section discusses the anatomy of plants in relation to food quality; the chief classes of food materials, carbohydrates, fats, and proteins; minerals and their importance in the diet; vitamins; and the storage, processing, and cooking of foods.

In the second section the vegetable foodstuffs are considered in detail, chapters being devoted to the cereal grains (general), wheat, maize, rye, barley, rice, oats, sorghums, miscellaneous small grains, pulses, oilseeds and edible nuts, fleshy and juicy fruits, leaf vegetables, stem and root vegetables, and cryptogams as sources of food.

A third section treats of vegetable drugs, poisons, stimulants, and other plant products of pharmaceutical interest. The drug plants of the *Rosaceae* and *Solanaceae* are discussed in detail; and then the drugs obtained from stems, leaves, bark, wood (including various distillates and exudations, such as resins and gums), flowers, fruits, seeds, or from cryptogams. Under each of these headings the individual drugs are urually grouped on the basis of their therapeutic uses or their chemical nature.

The final section is devoted to plants which cause some specific disease. Stinging hairs, inhaled dust, and other causes of various occupational diseases, the agents responsible for phyto-photodermatitis, pathogenic fungi, the allergens (such as poison ivy), and the sources of hay fever are all discussed. A chapter on plant identification and an index complete the volume.

ALBERT F. HILL

PHARMACEUTICAL BOTANY. *Seventh Edition.* *By Heber W. Youngken. The Blakiston Company, Philadelphia and Toronto.* $7.00. xviii + 752 pp.; ill. 1951.

Although the author, in his Preface to the Seventh Edition, states that he has broadened the scope of the book to serve the general liberal arts college as well as students in a college of pharmacy, I have the conviction, as a teacher in both a liberal arts college and a college of pharmacy, that the title—*Pharmaceutical Botany*—is retained advisedly. Like the previous editions, the Seventh Edition is an excellent textbook of botany for pharmacy students and will also serve them well as a reference work in their subsequent courses in materia medica and pharmacognosy. In the latter connection, Appendix II, on Histologic Technique, is especially useful.

Steps toward making the text cover the full scope of botanical science have been made by introducing some material on plant physiology and by a new chapter on metabolism; but the author fails to accomplish his purpose in so far as the liberal arts college student is concerned. The presentation of carbohydrate photosynthesis, especially, leaves much to be desired. Some discussion of the light and dark phases of the process and of the facts revealed by the radioactive isotope tracer technique applied in recent years should be included, even if in abbreviated form, in any textbook for the college level. To-day, it is generally the aim to make the botany course, or the botany part of the general biology course in colleges of pharmacy and in the liberal arts colleges essentially equivalent. To date, however, an appreciably greater exposure to plant physiology is given in most liberal arts colleges in comparison with the colleges of pharmacy, where greater emphasis is still given to plant histology. In the latter subject, Youngken's text indeed excels. Necessarily, the presentation of plant physiology will have to be expanded if future editions are to serve as a liberal arts college textbook as superbly as the Seventh Edition fulfils the requirements of a college of pharmacy curriculum.

Notwithstanding the fact that a number of chapters —such as those on The Root, The Inflorescence, The Flower, The Fruit, The Seed, and Genetics and Evolution—offer no significant changes in content nor in illustration, these chapters, which were outstanding in their presentation in the Sixth Edition (1938), are still excellent in comparison with other available textbooks. Even though the first paragraph of Chapter 1 is verbatim with the previous edition, p. 2 quickly makes the reader aware of the fact that the Seventh Edition is truly revised and improved.

One highly commendable improvement in format is the liberal use throughout the text of bold-face type and of italics to emphasize critical words and sections. This style should be an effective aid to the student. A considerable number of illustrations have been added and many old ones improved by substitution. For example, Fig. 1, Diagram of the body of a seed plant, edition 6 (1938), was good; but Fig. 1, Organization of a seed plant, edition 7 (1951), is definitely superior. Likewise, Fig. 185 replaces a poor photomicrograph of fennel with an excellent plate on the fennel plant (from Wallis). This is typical throughout the new edition. Wherever Youngken has substituted

a new source for a previously used diagram, he has chosen wisely and has greatly improved the value of the illustrations. He has also replaced some of his formerly utilized original drawings by others essentially new, e.g., Fig. 3, Blue-green Algae.

A few poorly reproduced photographs will be noted (Figs. 6, 12). M[illegible] new illustrations, however, original or borrowed, have enhanced the appearance and teaching effectiveness of the new edition. A curious omission occurs in the generally excellent Classified List of Reference Works. C. S. Gager's *General Botany* has been omitted, although the author has reproduced 51 illustrations from it in the present new edition.

The photographs in the chapter on Plant Environment should be improved in future editions. The treatment of the non-protoplasmic cell contents in the chapter on Plant Anatomy has been definitely improved. The inclusion of brief but well-chosen additional material has been made in the section of the same chapter on hormones and vitamins. Brief but critical additions to the chapter on the Classification and Naming of Plants have presented some of the more modern concepts. The Appendix on Histologic Technique has been expanded to include a number of new reagents, stain combinations, and relatively new techniques, such as Johansen's Tertiary Butyl Alcohol Method of Dehydration and Infiltration. Excellent reproductions of 2 photographs from Johansen's *Plant Microtechnique* should prove helpful to the student.

This standard textbook, which has served several generations of students so well, remains admirably adapted to the general botany course in the curriculum of pharmaceutical education.

RALPH HOLT CHENEY

HEVEA. *Thirty Years of Research in the Far East. By M. J. Dijkman; with a foreword by R. D. Rands. University of Miami Press, Coral Gables, Fla.* $6.00. xxii + 329 pp.; ill. 1951.

With Far Eastern sources of natural rubber gradually disappearing, the development of a rubber industry in the Americas is of vital importance to the United States. Furthermore, it is essential that all possible information in regard to this important crop be readily available. In the past a vast amount of literature on *Hevea* has been virtually inaccessible, since it was published in the Dutch language.

In this valuable book M. J. Dijkman, long an authority on the subject, presents in detail a critical interpretation of the results of the fundamental research on rubber carried on in Indonesia during the 30 years preceding the outbreak of the Pacific War. Although the subject matter will appeal primarily to rubber specialists and plantation personnel, it also stresses the development of small-scale holdings and the possibility of applying the knowledge gained to other tropical crops.

The chapter headings will give an indication of the scope of the work: Historical; Hevea as a Factor in the Economic Development of the East Indies; The Development of Rubber Research in Indonesia; Fertilizing and Soil Management; Planting Material; Growth; Tap and Tapping Systems; The Mechanism of Production and Related Phenomena; Growth, Yield and Disease in Relation to Planting Density; Diseases and Pests; Outline of Vegetative (Clonal) Selection; Outline of Generative Selection; The Results of Mother-tree Selection; Experimental Results with Vegetative and Generative Selection; Clones and Selected Seedlings under Commercial Conditions; Ecology and Rubber Improvement. A bibliography of the articles referred to concludes each chapter.

A series of appendices present the net exports of crude rubber; the make-up of the area in rubber in the main production centers of the Far East; descriptions and drawings of the best commercial Far Eastern clones; and data regarding the production of important primary and secondary clonal and selected seedling families from test areas in Indonesia.

The book is copiously illustrated with charts, diagrams, photographs, and figures. A glossary, an author index, and a subject index are supplied.

ALBERT F. HILL

TREES FOR AMERICAN GARDENS. *By Donald Wyman. The Macmillan Company, New York.* $7.50. vii + 376 pp. 1951.

This is a manual for landscape gardeners, park managers, and the like. The author lists the esthetic characteristics of 745 species and varieties of recommended ornamental and shade trees, with information on their habits of growth, environmental requirements, and resistance to pests. Purely botanical information is not included, nor will the book be of much use to the rank amateur, as insufficient information is given for a naive city dweller who would like to identify the trees which are being discussed. However, the book contains much practical and interesting information that should prove helpful to civic planners who do not want to see all the trees replaced by bigger and better parking areas.

EVELYN HOWARD

SOIL PHYSICAL CONDITIONS AND PLANT GROWTH. *Vol. 2. Agronomy—A Series of Monographs Prepared under the Auspices of the American Society of Agronomy.*

Edited by Byron T. Shaw; compiled by The Joint Committee on Soil Tilth, American Society of Agronomy, American Society of Agricultural Engineers. Academic Press, New York. $8.80. xvi + 491 pp.; ill. 1952.

This book is a critical treatise on soil physical conditions as related to plant growth. A complete and extensive literature review of about 1200 references, together with the authors' experience and interpretation makes for a comprehensive treatment of the subject. A general introduction to the soil as a physical system is followed by discussions of (1) mechanical impedance, (2) soil water, (3) soil aeration, and (4) soil temperature as related to plant response. Each of the above factors is considered in detail as it affects plant growth. The authors, however, recognize that plant response is the result of the interaction of all the environmental conditions to which the plant is subjected. The editor, Byron T. Shaw, provides an outline for future research in soil physics based on the material presented in this book. *Soil Physical Conditions and Plant Growth* is a suitable textbook for graduate courses in soil physics, and it will be a valuable reference work for agronomists, soil scientists and plant physiologists. It is of a technical nature and unadapted for popular reading.

GILBERT H. AHLGREN

GENERAL AND SYSTEMATIC ZOOLOGY

GENERAL ZOOLOGY. *Second Edition.*

By Tracy I. Storer. McGraw-Hill Book Company: New York, Toronto and London. $6.50. xii + 832 pp. + 4 pl.; text ill. 1951.

The first edition of this book has already been noted in these pages (*Q. R. B.*, 18: 279), and the present comments are therefore limited to a comparison between this revised edition and its predecessor. Since the format is about the same, and the number of pages differs by only 832 vs. 798, our attention falls on the textual changes. From the Preface we learn that the classification has been brought up to date, that additions have been made to such subjects as vitamins, hormones, genetics of human blood groups, the Rh factor, symbiosis, populations, human evolution, and the relation of genetics to natural selection. Although this might appear to be a considerable amount of change, an examination reveals actually only minor emendations and additions. For instance, under symbiosis we find only a change in the definition of terms; under human evolution, the addition of the fossil giants, but no discussion of the South African material; under populations, no change was discerned, although one might have had the wrong place; and under evolution one finds a new table that lists important contributions to cytology and genetics, but apparently nothing of importance has been discovered in these fields since 1934! While we do not want to carp from the sidelines, it does seem that "revised" is too strong an adjective to describe the nature of this latest edition.

HENRI C. SEIBERT

EINFÜHRUNG IN DIE ZOOLOGISCHE NOMENKLATUR *durch Erläuterung der Internationalen Regeln. Zweite, umgearbeitete Auflage mit der "Offiziellen Liste zoologischen Gattungs-Namen."*

By Rudolf Richter. Waldemar Kramer, Frankfurt-am-Main. DM. 8.50. 252 pp. 1948.

The only detailed discussion of all the rules and principles of zoological nomenclature is now available in a second and revised edition. Rudolf Richter is one of the most respected nomenclaturists and has been influential in zoological nomenclature for many years. His work deserves to be widely studied.

The principal part of the book is divided into two sections. The first is introductory, discussing the relationship between nomenclature and taxonomy, giving the history of the present International Rules, and outlining the auxiliary concepts employed in conjunction with nomenclature (types, genotypes, categories, synonymy, etc.). The peculiarities of paleontological nomenclature are cited, and the principles of priority and continuity are discussed.

The second section is interpretive. Each article of the Rules is taken up in order, quoted in full (in German translation), and then interpreted at length in the light of other rules, the Opinions, and the views of the author. In many cases this interpretation includes analyses of the published views of other workers.

Stability is cited as the major function of the Rules, but the so-called "principle of continuity" is not supported by Richter. He states that the "continuity principle" would lead only to continuity of chaos, and again, that continuity would be safe only through an objective and compulsory rule.

He makes the common distinction between two types of homonyms, which he calls objective (primary) and subjective (secondary). It appears that this distinction is accepted by him in spite of the fact that it is not made in the Rules. A lengthy discussion presupposes that it is inherent in the Rules—a view not shared by all nomenclaturists.

Problems of genotypy are dealt with at some length. A rather involved terminology (e.g., holo-genotypus typonymicus and lecto-genotypus) is employed, but it appears to be inadequate to distinguish the many means of genotype fixation. However, many of the common failures in the use of genotypes are analyzed, and the principles are discussed.

Although the *International Rules of Zoological Nomenclature* have at various times been unavailable be-

cause the supply was exhausted, they have been published several times before, in several languages. However, no such detailed discussion as this one of Richter's of all the rules has appeared heretofore. Four lists appended to this discussion appear to be unique, never before published in this form. They are therefore discussed below.

Official List of Generic Names in Zoology. An alphabetical list of all the generic names (643) placed on the Official List by the International Commission on Zoological Nomenclature. Names which were validated under Suspension of the Rules are shown in bold-face type, and in all cases the officially indicated genotype is cited. Reference is given to the Opinion in which the name was placed on the List, and the class in which the animal belongs is indicated.

List of Genotypes Determined by the Commission. An alphabetical list of genotypes (39) determined by the International Commission, other than those of names on the Official List above. These are determinations of the correct genotype under the Rules, except for 11 that were fixed under Suspension of the Rules (these are shown in bold-face type).

Suppression of the Species-name **vespertilionis.** A list of the 20 genera in which this name cannot be used (according to Opinion 128).

List of Decisions on the Legitimacy of Disputed Publications. A list of 30 works on the acceptability of which the Commission has ruled. Ten were declared illegitimate under Suspension of the Rules, and others were accepted in whole or in part, as indicated in the list.

This book should be of great interest to nomenclaturists, representing as it does the views of one of Europe's foremost students of this subject. Its direct usefulness may be impaired by the changes in the Rules planned at the Paris Congress in 1948 and likely to be adopted at the Copenhagen Congress in 1953, but the discussions of principle will not be affected.

It is much to be regretted that an English translation is not available, so that this unique contribution can be widely studied before the decisions on revising the Rules are taken.

R. E. BLACKWELDER

THE CLASSIFICATION OF ANIMALS. *An Introduction to Zoological Taxonomy. Methuen's Monographs on Biological Subjects.*

By W. T. Calman. John Wiley & Sons, New York; Methuen & Co., London. $1.25. viii + 54 pp. 1949.

This very short introduction to the principles of systematic zoology is an admirable work to place in the hands of a beginning student. The author discusses the need for classification in general, and of biological classification in particular, and then proceeds to consider the units of classification. He regards the species as a natural unit, but the higher categories as artificial. His definition of "species" is as follows: "A species is an assemblage of animals which do not differ from one another more than the offspring of a single pair may do; which are not connected with the members of neighbouring assemblages by intermediate forms; which interbreed freely with one another but commonly do not (in the wild state) interbreed with other species, or, if they do, produce infertile hybrids; and which usually inhabit geographical areas distinct from those inhabited by the most nearly related species." This definition is admittedly subject to qualifications and exceptions in every term. It should be noted, however, that Calman implicitly restricts his definition to sexually reproducing animals; and he fails to consider the problem of species in extinct forms, in asexual groups, in interhybridizing swarms of populations of the "reticulate" type, rings of races, etc.

The discussions of the International Rules of Zoological Nomenclature, descriptions and diagnoses of species, synonymy, references, illustrations, measurements, bibliographies, and museum work are clear, brief, and useful. There is an index.

BENTLEY GLASS

TRAITÉ DE ZOOLOGIE, ANATOMIE, SYSTÉMATIQUE, BIOLOGIE. *Tome 1.*

By Pierre-P. Grassé, Masson & Cie., Paris. 9000 fr. (paper); 9600 fr. (cloth). xii + 1071 pp. + 1 pl.; text ill. 1952.

The appearance of another volume of this important treatise will be welcomed by zoologists throughout the world. The present volume is the opening volume of the series and begins with a chapter on phylogenesis by the late L. Cuénot. Cuénot remarks on the division of the animal kingdom throughout the ages into large groups that do not evolve into other large groups and whose relation to each other is indeterminable. They are like leaves whose attachment to the tree is missing. For these large groups Cuénot rejects the name *phylum* and prefers *cladus*, borrowed from the *Handbuch der Zoologie*. He notes the recent tendency among zoologists to increase the number of phyla. Within each phylum, various lines (lignées) of evolution can be traced; as factors of such intraphyletic evolution, Cuénot leans heavily on orthogenesis, and further, on the fixation of large mutations, heterochrony, the irreversibility of characters, and progression from the generalized to the specialized. A phylogenetic tree is presented that follows the now universally accepted scheme of dividing the phyla above Onidaria into two lines of ascent, the one comprising the echinoderms, prechordates, and chordates, and the other embracing all the remaining invertebrate phyla. Following the characteristic French

habit of inventing new names for everything, these two lines are called Epineuria (= Deuterostomia) and Hyponeuria (= Protostomia). The arrangement of phyla along the Protostomia line is somewhat similar to my own. The flatworms come first with the Mesozoa regarded as degenerate flatworms; there follow the pseudocoelomate groups, mostly regarded as separate phyla. Next come the lophophore-bearers, or tentaculates as the Germans call them, properly including the Ectoprocta, Brachiopoda, and Phoronidea; but with them Cuénot also includes the Entoprocta (discarding like myself the old phylum Bryozoa) and further the Sipunculoidea, Priapuloidea, and Echiuroidea, while admitting the uncertainty of position of these last three. There is little doubt at present that the Echiuroidea are a class of Annelida. There then follow the Mollusca to one side, the Annelida to the other, and the line terminates with the Arthropoda, in the broad sense. Onychophora, Tardigrada, and Pentastomida are regarded as phyla separate from the Arthropoda. It is gratifying to find that zoologists have at last come to a considerable degree of unanimity as to the arrangement of the animal kingdom into phyla and tne disposition of these phyla with relation to each other.

Apart from the foregoing chapter of only 33 pages, the volume forms the first of three to deal with the Protozoa that will represent the most extensive treatment of this phylum yet published. Following a general discussion of the Protozoa (and other Protista) in which the concept of the Protozoa as non-cellular organisms is rejected, there is a good and well-illustrated account of protozoan structure and mitosis. The remainder and by far the greater part of the volume is devoted to an exhaustive account of the Flagellata (it is gratifying that the later but widely accepted name Mastigophora is altogether ignored). The Flagellata are taken up as groups called classes rather than by the usual designation of orders, and the division into classes differs from the standard arrangement only in that some small groups are elevated to the rank of classes. I feel that all of these groups are scaled on too high a level. Among the phytoflagellates, in addition to the usual 6 orders, there are recognized the Xanthomonadina for flagellates resembling the heterokont algae, the Ebriedia for some forms often placed among the dinoflagellates, and the Silicoflagellata and Coccolithophorida for families previously considered to be chrysomonads. Among the zooflagellates, the Protomonadina are split into 5 orders, such groups as choanoflagellates and trypanosomes being raised to the rank of orders, and the Polymastigina and Hypermastigina are divided among 9 orders. The opalinids are treated in this volume and are regarded as a group of zooflagellates. While there are certainly grounds for this arrangement, the evidence is hardly conclusive.

The volume is an indispensable reference work for students of the flagellate Protozoa. Like the other volumes of the treatise, this one too suffers from dearth of physiological and ecological information, but more attention has been paid to bibliographies. At the rear of the book is an unusually detailed and extensive table of contents as well as an adequate index.

LIBBIE H. HYMAN

MATERIALS AND METHODS IN THE STUDY OF PROTOZOA. *By Harold Kirby. University of California Press, Berkeley.* $2.50 (paper). x + 72 pp. 1950.

In the words of the author, this manual was "originally compiled for use in instruction—but the compilation has extended beyond the provision of directions for routine procedure in a laboratory course." There are three major sections. The first two concern the collection and cultivation of free-living and symbiotic protozoa, respectively, while the third concerns methods, mainly cytological, of study and preservation. This last section includes much material to be found in standard references on microscopical technique, but its emphasis on adaptations of the techniques to protozoa should make it of value.

In each main section, the subjects are listed alphabetically. This introduces some difficulties in listing, which are only partially met by cross reference entries and the general index. Nevertheless, this arrangement makes it relatively simple to locate desired items. The rather extensive bibliography at the end of each section greatly enhances the value of the manual.

Investigators who work mainly with one form may find favorite methods omitted and much material of no immediate use to them. However, the large variety of techniques brought together for the first time in readily available form should be a great aid for instructors and for investigators who work with a number of organisms and methods.

R. F. KIMBALL

AN INTRODUCTION TO NEMATOLOGY. *Section I—Anatomy. Revised.*

By B. G. Chitwood and M. B. Chitwood, with contributions by R. O. Christenson, L. Jacobs, and F. G. Wallace. Published by B. G. Chitwood, Box 104, Catholic University, Washington, D. C. $10.00. viii + 213 pp.; ill. 1950.

Parasitologists in general, and helminthologists in particular, will find *An Introduction to Nematology* worth having on their bookshelves. The senior author, in collaboration with his wife, has received just recognition as an authority in the field of nematode morphology. Though one may not agree entirely with the proposed classification of these worms, this hitherto ill-defined group has at least been brought together into some semblance of order. The free living "nemas,"

first brought into prominence by the late N. A. Cobb, along with the parasites upon both plants and animals, are given full consideration. Contributions by R. O. Christenson, L. Jacobs, and F. G. Wallace broaden this first section to include a thorough study of "nemic ova." Though many of the anatomical descriptions, including the accompanying plates, become highly involved at times and therefore of interest to only a few specialists, the comprehensive scope of the book will find some appeal to everyone.

The editing of the second section in this series in book form, and dealing with aspects of nematology other than anatomy, is eagerly awaited.

J. WALTER BECK

THE SHELL BOOK. *A Popular Guide to a Knowledge of the Families of Living Mollusks, and an Aid to the Identification of Shells Native and Foreign.*

By Julia Ellen Rogers. Charles T. Branford Company, Boston. $6.50. xvi + 501 pp. + 114 pl. 1951.

This is a reprint of a work that has been out of print for many years. It first appeared in 1908. The present issue has not been revised in any way, except that some of the original illustrations have been replaced by new ones. The systems of taxonomy and nomenclature enjoyed considerable popularity when first devised nearly three quarters of a century ago, but are now hopelessly out of date. There is an appendix of 17 pages at the end of the book in which the outmoded names are equated with their modern equivalents, but there is no very obvious reason why these should not have been used in the text. As it is, the beginner who wishes to identify his material must first learn the obsolete name, then the modern equivalent, then forget the former—three steps where one would have sufficed.

There are a few other pitfalls awaiting the beginner (for whom the book is obviously intended) which might have been eliminated had the text been revised. For instance, the two names *Pleurotoma maesta* and *Drillia moesta* refer to the same species, as do the names *Pleurotoma incisa* and *Drillia incisa*, although in each instance they are described as if they were distinct species. The species figured as *Haliotis cracherodii* is actually *Haliotis californiensis*. That figured as *Bulla nebulosa* is not that species but probably *Bulla quoyana*. That figured as *Modiola modiola* is apparently a *Mytilus*. The figures of *Omphalina fuliginosa* and *Gastrodonta ligera* have been transposed. *Carinaria* and *Atlanta* are not pteropods. The systematic position assigned to the Amphineura and the Anomalodesmacea are curious instances of taxomonic tmesis.

That part of the book which does not deal with molluscan systematics is well written. The illustrations are excellent. The chapters dealing with such subjects as the collecting and preparation of material for the cabinet, the maintenance of balanced aquaria, oyster culture, or pearl fishing will be found helpful and valuable to those who can see in a shell something more than calcium carbonate and terminology in medieval Latin. The index occupies only 5 pages but they are finely printed, and the index seems exhaustive.

COMPARATIVE GENITAL ANATOMY OF SOME AFRICAN ACHATINIDAE (PULMONATA). *Bull. Mus. comp. Zool Harvard, Vol. 105, No. 2.*

By Albert R. Mead. The Museum of Comparative Zoology, Harvard College, $2.50 (paper). Pp. 220–291 + 9 pl. 1950.

There are some families of Mollusca in which the modifications of the shell seem entirely uncorrelated with those of the soft parts, so that classification based exclusively on the one seems quite inconsistent with that based on the other. The Achatinidae appears to be such a family.

Within the past few years many families of the Pulmonata have undergone rather radical taxonomic revision, largely as the result of increased knowledge of their reproductive systems. The Achatinidae are destined to share this fate as their reproductive structures become better known. The present treatise is an important contribution toward that end. It is highly technical piece of work, not likely to have much appeal outside the specialists in the restricted field of pul monate anatomy. Yet its importance will be at once obvious to all students of molluscan anatomy and taxonomy.

JOSHUA L. BAILY, JR.

CEPHALODISCUS. *B. A. N. Z. Antarctic Research Expedition 1929–1931 Reports-Series B (Zoology and Botany). Vol. I, Part 3.*

By T. Harvey Johnston and Nancy G. Muirhead The B. A. N. Z. A. R. Expedition Committee, Adelaide. 10s. (paper). Pp. 89–120 + 3 pl.; text ill. 1951.

Five species of this interesting genus were obtained, including one new one, that is carefully described. There are useful lists of the pterobranchs collected by all southern expeditions and of all the localities from which pterobranchs have been dredged. The bathymetric range of this group lies between 50 and 600 meters.

L. H. HYMAN

AN INTRODUCTION TO ACAROLOGY.

By Edward W. Baker and G. W. Wharton. The Macmillan Company, New York. $10.00. xiv + 465 pp. + 1 pl.; text ill. 1952.

The increasing scarcity and ridiculously high dealer's price of Banks' (1915) old, brief, and once very useful review, *The Acarina or Mites*, reflects the wide and mounting need for a satisfactory, modern treatment in English of the biology, genera, and higher systematic categories of mites and ticks. Baker's and Wharton's book should very satisfactorily fill that need in so far as the systematics at the familial and higher categories is concerned. Since, furthermore, it provides an up-to-date catalog of the genera of mites, as well as many valuable yet brief discussions of wide-flung topics, this "Acarology" may be expected to become an indispensable reference from which new generations of workers will gain their orientation.

A brief analysis of the 5 recognized suborders of Acarina (the Tetrapodali being submerged in the suborder Trombidiformes) is followed by systematic treatment of each suborder, and in most instances dichotomizing keys are provided as a means for rapid decision as to which lower category, or family, specimens should be referred. The more than 200 families of mites are in turn characterized by a succinct diagnosis that is supplemented by one or more nicely executed line figures of a representative species, or anatomical detail. In each instance the included genera and their genotypes are thereafter listed and, where information warrants, there is also appended a brief discussion of life histories, host and vector involvements, economic importance, and so on. Appropriate references to the more comprehensive papers, systematic monographs, and significant notes are listed at the conclusion of the treatment of each family. It is noteworthy that most of these references are to papers that have appeared within the last 20 years or so, and in fact not a few appeared as recently as 1951.

It should, I think, be remarked that the introductory chapter—covering such diverse topics as modes of collection and preparation, ecology, terminology, internal and external anatomy, and life history—is not on a par with the general excellence of the rest of the work, nor even a satisfactory introduction to it. All of these topics should indeed have been dealt with, but what might be regarded as over-condensed in a tract of 100 pages is here encompassed in less than 34. The result is a confusing abbreviation of statement that requires a good deal more knowledge on the part of the reader than should be required by a purported *introduction* to the subject. The novice's comprehension of this portion of the text would have been greatly improved had the anatomical diagrams been specifically labelled. It does not seem reasonable that a longitudinal section of the body of a mite (fig. 27) should be unlabelled, that peritremes should be displayed without relation to the mite's gross anatomy (fig. 28), or a brain be figured (fig. 29) without some indication of its orientation, and so on. Considering the frequency with which the acarologist is confronted with immature forms, to shrug off the life cycle in a scant 2 paragraphs is perhaps the most glaring defect of all.

Nevertheless, it is a very excellent work, and criticism of the introduction should not dim our appreciation of the abundant virtues of this acarology, the only modern work of its kind in the English language. Medical workers, parasitologists, biologists, and of course the specialists, in fact all who ever need knowledge about mites, will welcome this vade-mecum of systematic acarology.

KENNETH W. COOPER

THE MITES OF THE SUBFAMILY HAEMOGAMASINAE (ACARI: LAELAPTIDAE). *Proc. U. S. natl. Mus., No. 3275, Vol. 101.*

By Hugh L. Keegan. Smithsonian Institution, United States National Museum, Washington. Paper. Pp. 203–268; ill. 1951.

This revision includes descriptions of 3 new species, two of which are placed in the new genus *Ischyropoda*, of California and the U. S. Southwest.

REVISION OF THE NEARCTIC SPECIES OF THE POMPILID GENUS PEPSIS (HYMENOPTERA POMPILIDAE). *Bull. Amer. Mus. nat. Hist., Vol. 98, Art. 4.*

By Paul David Hurd, Jr. American Museum of Natural History, New York. $1.00. Pp. 261–334 + 1 folding map; ill. 1952.

Pepsis is a strictly American genus that collects together the large and frequently showy spider wasps commonly known as tarantula hawks. The surprisingly scant and often disconnected accounts of the biology of the species of *Pepsis* are summarized and evaluated here by Hurd, and the distribution of these wasps over the two Americas is reviewed. Separate treatment is given to males and females in the taxonomic key, and the 15 species and their variants occurring within the United States are described. The keys are very workable, and the descriptions of the named forms apt, to judge from the ease with which the limited material at my disposal was classified. It is not surprising that this troublesome genus has at last been placed in such good order for our forms, for Hurd has labored enormously, bringing together and studying nearly 10,000 specimens. That very large sample made possible a fairly exact description of the geographic ranges of the

species and variants that occur in the United States, and these are summarized in map form.

Completing this very fine monograph are a catalog of the more than 500 names applied to forms within *Pepsis* (whose population center seems to be Minas Geraes in Brazil), brief notes on the subgenera of *Pepsis*, and a very extensive bibliography. With this revision of *Pepsis*, the notable monographs of the Pompilinae by Bradley and Evans, and the studies in progress by Townes, the pompilids are fast attaining the status of being the best understood major family of wasps in our fauna. This is noteworthy, for less than 10 years ago the taxonomy of the Pompilidae was chaotic, ambiguous, and virtually unworkable.

KENNETH W. COOPER

BRITISH BUTTERFLIES.

By E. B. Ford, with sixteen color plates by Paxton Chadwick. Penguin Books, Harmondsworth, Middlesex. 95 cents. 31 pp. + 16 pl.; text ill. 1951.

Butterflies, because of their striking colors, are probably the only group of well-known insects tolerated with any degree of sympathy and admiration by man. Their graceful flight, patterns of variation, and association with flowering plants put them in a class by themselves so far as the layman is concerned, yet from the point of view of the scientist they hold an even greater interest. Their genetic variability, feeding habits, ecological associations, migratory habits, and coloration pigments raise a host of questions, only a few of which have been answered. It is with these questions, rather than with the general descriptive aspects, that Professor Ford has concerned himself, with the result that within the short space of 30 pages some of the more interesting problems of the natural history of butterflies are raised in a way that the layman can understand and appreciate. Together with the beautifully executed colored plates by Paxton Chadwick, the volume, small though it be, is one of absorbing interest, good writing, and exceptional beauty.

C. P. SWANSON

THE SATURNIIDAE (LEPIDOPTERA) OF THE WESTERN HEMISPHERE. *Morphology, Phylogeny, and Classification. Bull. Amer. Mus. nat. Hist., Vol. 98, Art. 5.*

By Charles D. Michener. American Museum of Natural History, New York. $2.25 (paper). Pp. 341–501 + 1 pl.; text ill. 1952.

This work, of great taxonomic and phylogenetic importance to all students of the Lepidoptera, may also be studied with profit by anyone engaged in any work on phylogeny and evolution. The Saturniidae, containing the largest and some of the most strikingly colored of the moths, have been much collected and studied; but most of the past work is not very useful since their genitalia and other structural characters have been little used. The present monograph, which covers only generic (and subgeneric) and higher categories, is intended to be basic to a projected series of publications that will completely revise the New World Saturniidae. Two new species are named as a matter of convenience. A considerable number of genera and subgenera, proposed by the author in previous short papers, are for the first time adequately described and diagnosed. A very valuable description of the morphology of *Eacles imperialis* (Drury) establishes a uniform terminology for this and the projected papers that are to follow. The comparative morphology of the genera is discussed. Characters believed to be recognizable as "primitive" or "specialized" are tabulated, and a considerable number of evolutionary trends (including many parallelisms) is discussed.

The generic and subgeneric synonymy, with citations of the type species and their designations, is given in full and is adequately covered by bibliographic references. There are 61 figures of venation and 324 of male genitalia, illustrating the majority of the type species of the genera and subgenera. The lack of an index is a serious matter in a work of this magnitude. And some day the work will have to be redone, using the female genitalia as well.

ALEXANDER B. KLOTS

HOW TO KNOW THE BEETLES. *Pictured-Keys for identifying many of the beetles which are most frequently seen, with aids for their study and with other helpful features. Pictured-Key Nature Series.*

By H. E. Jaques. Wm. C. Brown Company, Dubuque. $4.25 (cloth); $3.25 (paper). vi + 372 pp.; ill. 1951.

This is another volume in the Pictured Key Nature Series. After a brief introduction in which the terms are defined, keys are presented for identifying the families of beetles occurring in North America, and then of genera and species of each of the 109 families. A characteristic feature of this series is the liberal use of illustrations. Drawings of about 900 species are given, and many of the key characters on which identification depends are made clear by figures rather than the use of many words.

This is in the reviewer's opinion, the most valuable feature of this book. The beginner, for whom this book is chiefly meant, can in many cases obtain the name of a beetle by leafing through the book and looking at the pictures, or if he uses the keys conscientiously can find out easily whether he is anywhere near correct.

The use of the keys which go down to species when

only a relatively small fraction (about 5 per cent) of the total existing number of species is listed is of course problematical, even though most of the common species can be found. The reader should, however, have no illusions about his being able to identify more or less automatically any beetle he comes across. Apart from the fact that the majority of species are omitted, there are errors in the tables. Some are due to the complexity of the subject, and for these the author can hardly be blamed, as they occur in most books of this type, even much more pretentious ones. Others are due to plain carelessness, such as is encountered when an attempt is made to identify the common Mexican bean beetle. If the reader starts out on p. 197 with the family Coccinellidae, couplet 2, which gives the choice between "body compact, usually oval", and "body loosely jointed, usually rounded", may give him some bad moments; but if he chooses the latter he is led to couplet 8, which gives a choice between a pubescent or glabrous upper surface. If he trusts his eyes and chooses the former, he is led into a blind alley. If disregarding what he sees, he makes himself believe that the upper side is glabrous and follows this choice, he is in couplet 11 paradoxically put once again before the choice whether the "glabrous" beetle is pubescent or glabrous and this time he must choose "pubescent". The advice to trust the figures rather than the text seems therefore well justified.

With these limitations, the book can be used to good advantage by the beginner to get acquainted with the great variety of beetles. It is a pity that there is no bibliography of the publications where more complete descriptions and keys of the various groups can be found. Such a bibliography is given by Edwards in *Coleoptera or Beetles East of the Great Plains* (1949) with bibliographical supplement (1950). This book covers much the same ground as the one under discussion, but with different treatment. The reader may well use both of them, as they supplement each other. He would, however, find that he could not identify the Mexican Bean Beetle with either of them.

G. H. DIEKE

THE CARABID BEETLES OF NEW GUINEA. *Part 2, The Agonini. Bull. Mus. comp. Zool., Harvard, Vol. 107, No. 3.*

By P. J. Darlington, Jr. Museum of Comparative Zoology at Harvard College, Cambridge, Mass. $1.75 (paper). Pp. 89–252 + 4 pl. 1952.

This is the beginning of a monograph on the Carabidae of New Guinea; Part 1 has not yet appeared. 19 genera and 121 species and subspecies are described, most of them not heretofore known. While the bulk of the monograph will appeal mostly to the specialist of the Carabidae, there are some parts of more general interest, such as the discussion of the evolutionary aspects of the carabid fauna of New Guinea and the role of geographical isolation. A number of drawings of the male genitalia will make a definite identification of the described species easier.

G. H. DIEKE

EXPEDITION TO SOUTH-WEST ARABIA, *1937–8. British Museum (Natural History) Vol. I, Nos. 16–19.*

By J. Balfour-Browne, E. S. Brown, A. P. Kapur, and René Jeannel. The British Museum, London. 20s. (paper). Pp. 179–304 + 4 pl.; text ill. 1951.

Contents: 16. Coleoptera: Haliplidae, Dytiscidae, Gyrinidae, Hydraenidae, Hydrophilidae (J. Balfour-Browne). 17. Aquatic and Semi-aquatic Hemiptera. 18. Coleoptera: Coccinellidae (A. P. Kapur). 19. Coleoptera: Pselaphidae (René Jeannel).

An account of the fauna of S. W. Arabia in the indicated groups. Zoographic and taxonomic data are given, as well as a few scattered biological and ecological data. A number of new species is described. The fauna of S. W. Arabia is interesting because it seems to be a mixture of endemic species and what is common with the north (Palaeartic), the east (Oriental), and the west (Ethiopian). The distribution in the group treated here is as follows:

	16 Water Beetles	17 Water Hemiptera	18 Coccinellidae	19 Pselaphidae
Endemic	18	5	7	—
Palaearctic	25	4	17	—
Ethiopian	20	17	7	7
Oriental	5	2	1	—
Generally distributed	6	—	—	—
Ethiopian oriental	—	5	—	—

The plates give photographs of collection sites. Some of the new species and structural details are presented in text figures.

G. H. DIEKE

A REVISION OF THE BEETLES OF THE GENUS MYOCHROUS. *Proc. U. S. natl. Mus., Vol. 101. No. 3271.*

By Doris Holmes Blake. Smithsonian Institution, U. S. National Museum, Washington, D. C. 64 pp. + 8 pl. 1950.

Among the economically important chrysomelid beetles is the genus *Myochrous*, which includes the southern corn-leaf beetle. The current revision includes 50 species, of which no less than 33 (6 in the United States, 5 in Mexico and Central America, and 22 in South

America) are here described as new. To any biologists who may suppose that by now most of the animal species have been named and described, this ought to offer a mild and salutary shock!

BENTLEY GLASS

A DICTIONARY OF FISHES. *2nd Edition.* *By Rube Allyn; illustrations by Maggie May, Joe Roberts, and Griffin Richcreek. Great Outdoors Association, St. Petersburg, Fla.* $3.50. 108 pp. + 4 pl.; text ill. 1951.

"What kind of a fish is this?" Anyone who has fished has asked the question which Allyn has set about to answer, at least for the fishing enthusiast who is not particularly concerned with all of the niceties of scientific description, family affinities, and specific differences. A tremendous number of fish are discussed here, as to location, general appearance, feeding habits, and game characteristics. The sportsman will find it a generally useful book. A number of colored plates adds to its attractiveness.

AMPHIBIANS OF WESTERN NORTH AMERICA. *By Robert C. Stebbins. University of California Press, Berkeley and Los Angeles.* $7.50. xviii + 539 pp.; ill. 1951.

22 species of salamanders and 29 species of frogs and toads have received admirable treatment in this informative and attractive volume. Stebbins, who has had extensive field experience with western amphibians, has been fortunate in having the comprehensive collections of the Museum of Vertebrate Zoology readily available. When it is further realized that he is an accurate observer, a careful recorder, and a skilled artist, the excellence of this book is assured.

The bulk of the volume is made up of individual accounts of species. Each species is treated as a unit and is followed by a short discussion of its component races. In some of these discussions, Stebbins points out a view different from that held by the most recent authors. His estimate of the systematic arrangement of the races of *Triturus granulosus*, for example, seems to describe the facts better, in my opinion, than any other so far presented. In some instances these discussions (e.g., that of *Bufo microscaphus*) are essentially separate original contributions.

The topics included for many of the species are: range, type locality, description, habitat, behavior, thermal data, food, reproduction, key to subspecies, and remarks. There are black-and-white and colored plates of most of the species. With one exception (*Ensatina*), the colored plates have been beautifully reproduced. The illustrations also include a series of diagrammatic text figures which are frequently utilized to clarify the keys. There are also photographs of habitats and distribution maps. The latter utilize the desirable features of both the spot map and the Ben-Day stipple. A glossary, bibliography, and index conclude the book.

Errors are rare. The characterization of the Amphibia as possessing a 3-chambered heart overlooks the secondary absence of an interauricular septum in the lungless salamanders.

A final word of praise should be given to the University of California Press. This book has been very attractively and thoughtfully designed.

A. GROBMAN

A GUIDE TO BIRD FINDING EAST OF THE MISSISSIPPI. *By Olin Sewall Pettingill, Jr.; with illustrations by George Miksch Sutton. Oxford University Press, New York.* $5.00. xxi + 659 pp.; ill. 1951.

We hope that we may be excused for paraphrasing the introductory description of the plan of this book. No other words could do it better. In scope the book covers the 26 states lying east of the Mississippi River. For each state, places for bird finding were chosen to show species of birds; important bird concentrations; representative types of bird habitats; and the diversity of birds existing near large metropolitan areas and vacation centers. National Parks, Refuges, Monuments, and Forests, as well as state and private lands, museums, libraries, colleges, universities, research stations, zoos, and any other features of ornithological interest are included. Each chapter, arranged by states, refers to the physiographic features and biotic communities that are characteristic, and to the breeding birds therein. Interesting migrants are also included, but many species too common to warrant mention are omitted. Any peculiarities of migration and winter birdlife are mentioned.

Ornithologists have long awaited a guide of this nature, and they are indeed fortunate to get such an excellent one now. All that one must do is to locate in the index a particular species and thereby determine the best locality in which to find it. Conversely, for any geographical area, one can determine what birds of interest are likely to be seen. G. M. Sutton has provided pen-and-ink sketches of the birds characteristic of each state. Strangely enough, the comments on this book that have been overheard criticized the drawings as being valueless for identification purposes! Obviously that is not the reason for the drawings. Admittedly not all are up to Sutton's best, but as decorative sketches they meet the need admirably.

Only actual trial will reveal any drawbacks in the book, but a priori it seems likely to fulfil its purpose. A companion volume for the birds of the West is to follow soon.

HENRI C. SEIBERT

BIRDS' NESTS OF THE WEST. *A Field Guide. An Identification Manual to the Nests of Birds of the United States West of the One Hundredth Meridian.*

By Richard Headstrom. Ives Washburn, New York. $2.50. 177 pp. + 24 pl. 1951.

This is a key to the identification of bird nests to be found west of the 100th meridian. The first dichotomy is between those nests on the ground and those off the ground. Within each of these categories the procedure employs the location (habitat) of the nest, whether open, arched, or pendent, the materials of which it is composed, its size and general shape. Included are 29 photographs of different types of nests. Whereas the first part of the key should provide no difficulty, the final decision as to species will require careful reading. I am not convinced that positive identification will always result. Nevertheless, a great majority of nests can be identified with assurance from the Guide, and this is particularly helpful in the fall when the nests become rather conspicuous. A general summary of the bird's breeding range helps to narrow the choice. This volume is a companion to a similar one for the birds of the East. Together, they form the best guides available in this field.

HENRI C. SEIBERT

BRITISH MUSEUM (NATURAL HISTORY) CHECKLIST OF PALEARCTIC AND INDIAN MAMMALS *1758 to 1946.*

By J. R. Ellerman and T. C. S. Morrison-Scott. The British Museum, London. £3 5s. vi + 810 pp. 1951.

The title "Checklist" inadequately describes this revision of the entire mammalian fauna of an area that includes Europe, Asia (except the Malay Peninsula below 10°N, Indonesia, and the Philippines), and North Africa (above 20°N). In evaluating the voluminous literature some nomenclatural changes have been inevitable. These seem to be most frequent among the Cetacea. A summary is included of the authors' petitions to the International Commission regarding the status of names credited to Frisch 1775, Oken 1815–16, Brisson 1762, and Rafinesque 1815. Granting of these will validate *Dama, Citellus, Pan, Vulpes, Cuniculus, Glis, Meles, Tragulus, Muntiacus,* and other genera as now used. In dubious cases of synonymy the authors have presented both their own opinion and the rejected alternative, together with an evaluation of present knowledge and a statement of what is needed to resolve the problem. This should be invaluable to future systematists. The section on rodents virtually conforms with Ellerman's recent more comprehensive work. The section on the Lagomorpha constitutes a complete revision of all Old-World species, including those of Africa, and suggests that North American species may be implicated.

The modern trend toward "lumping" of species and genera is generally followed. One exception is the authors' "lumping" of *Felis* and *Lynx* while at the same time "splitting" *Felis* and *Panthera*. Another trifle to which perfectionists may take exception is the failure to place parentheses around authors' names whose species have been removed from the original genus. However, these criticisms are mere compared to the uniform excellence characterizing the entire volume. Here indeed is a standard reference for all mammalogists, whether European, Asiatic, or American.

BRYAN P. GLASS

A SYSTEMATIC REVIEW OF THE HARVEST MICE (*Genus Reithrodontomys*) OF LATIN AMERICA. *Misc. Pub., Mus. Zool., Univ. Mich., No. 77.*

By Emmet T. Hooper. University of Michigan Press Ann Arbor. $4.00. iii + 255 pp. + 9 pl.; text ill. 1952.

The University of Michigan Museum of Zoology has joined the ranks of institutions that are assuming the work of producing taxonomic monographs in mammalogy formerly carried out largely by the U. S. Biological Survey. The present volume is organized in North American Fauna style, and is essentially a revision of Fauna No. 36, *A Review of the American Harvest Mice,* by Howell. The revision is extensive, reporting on many new collections from south of the border, and follows the modern trend towards reduction in the number of full species recognized. Howell recognized 25 species; Hooper admits only 16. Most of the names used by the latter are to be found in Howell's review, but there are some resurrections from synonymy, and a few names are recent enough not to have appeared in the earlier monograph. The book contains a painstakingly detailed description of the teeth and their terminology, some data on breeding, molts, and age classes, a number of excellent distribution maps, a series of photographic plates of skulls, and an extensive gazeteer of Latin American place names. It is regrettable that an arbitrary political boundary has been allowed to limit the scope of this study, which otherwise leaves so little to be desired.

BRYAN P. GLASS

ECONOMIC ZOOLOGY

INSECT CONTROL BY CHEMICALS.

By A. W. A. Brown. John Wiley & Sons, New York; Chapman & Hall, London. $12.50. viii + 817 pp.; ill. 1951.

This book presents a very comprehensive treatment of the factors involved in the chemical control of insects. The material is organized in 11 chapters liberally interspersed with tables, graphs, and illustrations, and contains reference to 2300 original papers. There is an adequate 36-page index. The make-up of the book and the quality of the printing and illustrations are excellent.

The first 2 chapters of the book discuss modern insecticides, their chemical and physical properties, and the relation of the structure of organic chemicals to insect toxicity. Succeeding chapters deal extensively with the entry of poisons into the insect body and the pharmacology of insecticide action. Two outstanding chapters are devoted to the equipment used to apply insecticides from the ground and air and include a very thorough description of the physical principles involved.

The chapter on toxicity and the hazards of insecticides to man and domestic animals provides the most thorough, modern, and unbiased summary of this subject with which I am acquainted. There follows a unique chapter on the toxicity of insecticides to plant growth. Two chapters deal, in general, with the employment of various insecticides to control plant-feeding pests, and pests of man and animals, while the final chapter discusses the effects of insecticides on the balance of animal populations, and discusses such important topics as effects on wildlife and bees, insecticide resistance, and an introduction to quantitative toxicology

This book can be recommended without reservation to those interested in the serious study of economic entomology. Close appraisal of its contents will demonstrate irrefutably that economic entomology is one of the most exacting of scientific disciplines and a field that will profit much from a better understanding of the physical and chemical principles involved in its practice.

R. L. METCALF

CITRUS ENTOMOLOGY IN THE MIDDLE EAST, *with special references to Egypt, Iran, Irak, Palestine, Syria, and Turkey.*

By F. S. Bodenheimer. W. Junk, The Hague. D. Fl. 56.—. xii + 663 pp.; ill. 1951.

Rarely does a scientific book have a more adventurous history than this one, the manuscript of which was sent to Holland during the early days of the late war and lay hidden in a Dutch fishing village during the German occupation. It was subsequently returned in good condition to the author and completely revised. Citrus entomology represents a highly specialized field, and this work is even more restricted in emphasis to the locale of the Middle East. However, the detailed ecological studies presented, the wealth of original data and illustrative material, and the extensive and worldwide coverage of literature make this a valuable reference work for the citrus entomologist and the student of insect biology and ecology.

The material is organized into an introductory section of 4 chapters dealing with the history of citrus culture in Palestine, the animal ecology of citrus groves, the zoogeographical and ecological survey of citrus pests, and a symptomatic key to the citrus pests of Palestine. The second part, of 13 chapters, grouped by insect order, deals in great detail with the description, distribution, life histories, physiology, ecology, injury, and control of the citrus pests, including insects, mites, nematodes, snails, and vertebrates. This portion of the text is remarkable for the astonishing wealth of ecological information regarding the various pests which is presented in more than 700 tables and graphs.

The final chapters consider citrus pests in Egypt, Cyprus, Lebanon, Syria, Turkey, Transcaucasia, Iraq, and Iran, and the principles, technique, and organization of citrus pest control in Palestine. It should be mentioned that the sections on pest control are devoted largely to the use of fumigation and spray oils and do not cover the uses of modern post-war organic insecticides, which are widely employed for citrus pest control in the United States.

Altogether, this book sets a high standard for future entomological works dealing with insect biology and ecology. The printing and illustrations are of the highest quality. The convenient use of the valuable reference material is seriously hampered by the inexplicable failure to provide any index.

ROBERT L. METCALF

MALAYAN FISHERIES. *A Handbook Prepared for the Inaugural Meeting of the Indo-Pacific Council, Singapore, March 1949.*

Edited by G. L. Kesteven; foreword by the Right Honourable Malcolm MacDonald. Malaya Publishing House, Singapore. viii + 88 pp. + 17 pl. + 1 folding map; text ill. 1949.

PROCEEDINGS OF THE SECOND MEETING OF THE INDO-PACIFIC FISHERIES COUNCIL. *Sections I, II, and III. Indopacific Fisheries Council, Bangkok.* Gratis (paper). I, 47 pp.; II & III, 189 pp. 1950; 1951.

COMMUNICATIONS PRESENTÉES AUX 1e ET 2e SESSIONS DU CONSEIL INDO-PACIFIQUE DES PÊCHES.

Service de la Pêche et de la Chasse en Indochine. Paper. 115 pp.; ill.

If these publications consisted of nothing more than the usual speeches of political dignitaries, they would deserve little more than listing. However, the handbook on *Malayan Fisheries* contains material of interest to geographers interested in fishing methods and human ecology, and the 1951 installment of the 2nd meeting consists principally of technical papers, including an excellent symposium on the hydrography and ecology of estuaries in eastern Asia and Australia.

JOEL W. HEDGPETH

FORTIETH BIENNIAL REPORT OF THE DIVISION OF FISH AND GAME FOR THE YEARS 1946–1948. *State of California, Department of Natural Resources. California Fish and Game Commission, Terminal Island, Cal.* Paper. 118 pp.; ill. 1948.

This Report includes, in addition to the usual statistics, abstracts of unpublished biological reports of investigations by the biologists of the Division.

MORPHOMETRY, GROWTH, AND AGE OF TUNAS. *Special sci. Rept., Fisheries No. 22. Translated from the Japanese language by SCAP translators and W. G. Van Campen; edited by B. M. Shimada and W. G. Van Campen. U. S. Department of the Interior, Fish and Wildlife Service, Washington, D. C.* Paper. i + 30 pp.; ill. 1950.

A COMPARISON OF THE BLUEFIN TUNAS, GENUS THUNNUS FROM NEW ENGLAND, AUSTRALIA AND CALIFORNIA. *Fish Bulletin No. 77. By H. C. Godsil and Edwin K. Holmberg. California Department of Natural Resources, Division of Fish and Game, Bureau of Marine Fisheries, Terminal Island, Cal.* Paper. 55 pp.; ill. 1950.

SWINE HUSBANDRY. *Animal Agriculture Series. By M. E. Ensminger. The Interstate Printers and Publishers, Danville, Ill.* $4.00. 378 pp.; ill. 1952.

This book follows the same organization as that used by the author in companion textbooks on beef cattle, sheep, and horses. It is intended primarily for college and high school students, but should attract the interest of practical swine producers of the United States. There are chapters on the history, types and breeds of swine, and the economics of the swine industry. The feeding of swine, including such factors as nutritional requirements, practical swine rations, and the utilization of pasture are dealt with in 4 chapters. These chapters were reviewed by well known nutritionists and swine production specialists and summarize current views. Unfortunately, few literature citations of current researches have been made. Leo Bustad is coauthor of the chapter on the more common diseases and parasites of swine. Breeding, marketing, and fitting swine for show are discussed in separate chapters. The text contains numerous photographs as well as drawings by R. F. Johnson.

FREDERICK N. ANDREWS

RAISING SWINE. *By George P. Deyoe and J. L. Krider. McGraw-Hill Book Company; New York, Toronto, and London.* $3.60. xii + 447 pp.; ill. 1952.

This book is written primarily for the vocational agricultural student and the practical swine producer. The style is particularly well adapted for secondary school teaching. Each chapter contains a topical preview of the most important points to be covered and ends with a summary of the approved practices stressed. The book is written in nontechnical language but is authoritative and current, especially in the rapidly changing field of swine nutrition. The economic factors associated with practical swine production, such as economic geography, purchasing swine, record keeping, work simplification, and marketing are discussed in 4 chapters. The nutritional requirements of swine and practical rations for meeting the requirements occupy 2 chapters. There are separate chapters on general management, diseases and parasites, swine breeding, and the processing of pork for home use.

FREDERICK N. ANDREWS

SHEEP HUSBANDRY. *Animal Agriculture Series. By M. E. Ensminger. The Interstate Printers and Publishers, Danville, Ill.* $4.00. 404 pp.; ill. 1952.

This book was written for use as both a college and high school textbook and in addition to meet the needs of practical sheep producers on farms and ranches in the Americas. The author acknowledges the assistance of a large number of reviewers. Nine of the 23 chapters have been reviewed by one or more recognized authorities, and a chapter of 61 pages on diseases and parasites of sheep and goats has been written jointly with Leo Bustad. The book is well illustrated with photographs, and also with numerous drawings by R. F. Johnson. The text includes information on the origin, history, and development of the various breeds of sheep and goats, and on the economic geography of the industry. The basic elements of sheep production, such as

breeding, feeding, management, and equipment are covered in separate chapters. There is a short chapter on the marketing and processing of sheep and lambs. Two chapters deal with wool technology. The book is concisely written, and treats standard practices rather than controversial or special sheep problems.

FREDERICK N. ANDREWS

ANIMAL GROWTH AND DEVELOPMENT

INFANT DEVELOPMENT. *The Embryology of Early Human Behavior.*

By Arnold Gesell. Harper & Brothers, New York. $3.50. xii + 108 pp.; ill. 1952.

Gesell is well known for his many years of research in the field of child development. In this book he has summarized the normal growth cycle of infants and the development of behavior patterns in the first 2 years of life. From this base he formulates the principles of differential diagnosis in the behavior patterns of children and points out, in a thoughtful and philosophical fashion, the importance of understanding these patterns when working with the individual child. This is a short volume illustrated with some of the splendid pictures Gesell has made of youngsters in action. It is important as a summary of his thinking and feeling about the implications of his life's work.

HELEN ARTHUR

ATTAINING MANHOOD. *A Doctor Talks to Boys About Sex. Second Edition, Revised and Enlarged.*

By George W. Corner. Harper & Brothers, New York. $1.50. viii + 97 pp.; ill. 1952.

ATTAINING WOMANHOOD. *A Doctor Talks to Girls About Sex. Second Edition, Revised and Enlarged.*

By George W. Corner. Harper & Brothers, New York. $1.50. xiv + 112 pp.; ill. 1952.

These two short books are revised, second editions of the original volumes which were published in 1939. In them, Dr. Corner, as it says on the dust jackets, "talks to boys (to girls) about sex." He does a splendid job, too, of taking up with pleasant matter-of-factness every important area of sex education. His simple, direct formulation of the scientific facts, interpreted with understanding and sympathy, makes these books ideal for the adolescent reader.

The material covered is essentially the same in each book. The author describes, with the help of excellent illustrations, the human reproductive system, explains how babies are conceived, and describes their growth in utero. He takes up, without moralizing but with realistic common sense, the subjects of sex conduct, sex problems (in girlhood and in boyhood), and venereal disease. Altogether Dr. Corner has made an important contribution to a teen-agers' library.

HELEN ARTHUR

MOTOR PERFORMANCE AND GROWTH. *A Developmental Study of Static Dynamometric Strength.*

By Harold E. Jones. University of California Press, Berkeley and Los Angeles. $3.00. xii + 181 pp.; ill. 1949.

This book reports a study of the development in 4 aspects of muscular strength (right grip, left grip, pull, thrust) in 89 boys and 87 girls from the age of 11 to 17.5 years. Correlations between strength and physique (high) and between strength and socio-economic status (none) were calculated; and different types of growth curves were plotted. The effects of early and late sexual maturing and of the puberal growth spurt were among the relationships considered.

ANIMAL MORPHOLOGY

ESSENTIALS OF HISTOLOGY. *Second Edition.*

By Margaret M. Hoskins and Gerrit Bevelander. The C. V. Mosby Company, St. Louis. $4.00. 240 pp. + 2 pl.; text ill. 1952.

This small textbook is most elementary, dealing with its subject in the simplest possible fashion. Each tissue or organ is described in whatever way will make it appear simplest and clearest to the beginner, without reference to fundamental patterns of structural organization. This lack of coherence is combined with the inaccuracies of brevity and a somewhat scrambled terminology. The line drawings illustrate the text adequately enough. The book is not recommended for use by those who will pursue the subject beyond an elementary course.

F. N. LOW

AN ATLAS OF HUMAN ANATOMY.

By Barry J. Anson. W. B. Saunders Co., Philadelphia and London. $11.50. xxii + 518 pp.; ill. 1950.

This excellent atlas of gross human anatomy, arranged by regions rather than by systems, is the result of a long-term project. It is "based upon new dissections, serially prepared, and upon variable morphological features statistically presented." Many of the drawings are founded on unpublished studies of the author and his colleagues. Anomalies as such are not emphasized, but are presented "as predictable elements in a natural

series of variations." This treatment of variations is a unique feature for books of this type and should prove of great value in impressing the student with the fact, all too often forgotten, that there is a perfectly normal range of biological variability, even in man. The "textbook type" of man has been, and still remains, a blight upon the teaching of human anatomy, with consequent ill effects upon the whole outlook of the student toward the human organism. Anson's book should help to correct this condition.

Most of the 432 pages of illustrations are in black and white. In fact, color is used on only 52 pages, or about 11 per cent, and, on most of these, sparingly; but this does not seriously detract from the usefulness of the book. Anson is to be congratulated for having produced a book that is a distinct contribution to the understanding of the human body. It is certainly one of the very best atlases of gross human anatomy now available in any language.

W. L. Straus, Jr.

An Atlas of Anatomy. *3rd Edition.*

By J. C. Boileau Grant. The Williams & Wilkins Company, Baltimore. $12.00. xii + 637 figs. + index. 1951.

Previous reviews of the first (*Q.R.B.*, 19: 61. 1944) and the second (*Q.R.B.*, 23: 65. 1948) editions of this atlas have praised its fine quality. The third edition has more than 70 new figures on miscellaneous regions. Alterations have been made to old illustrations, color having been added to some. The pages are not numbered in this edition. References in the table of contents (oddly but aptly titled, Illustrations) and the 20-page Index are to figure numbers only.

At the risk of maligning a fine work, some criticisms may be offered. The approach is regional, and most illustrations portray all parts present, a circumstance that reduces the detail in which any particular structure may be portrayed. Very few are seen in their entirety. The accompanying text is similarly restricted, there being little opportunity for a complete description of many of the structures. It appears that the text has been reduced even beyond the restrictions imposed by the nature of the illustrations. More text would be helpful, even at the risk of approaching a textbook.

It is fashionable to disparage the great scholarly anatomies of the past, to say that they are tedious and over-meticulous. Nevertheless, the serious student in search of exact, authoritative detail still finds works such as the *Hand Atlas of Human Anatomy* by Spalteholz indispensable, because therein is the best and most complete information. The scholars of 50 to 100 years ago aimed at a thorough and accurate coverage of their fields, and produced the finest pure anatomies ever written. Now times have changed, and the pressure of modern medical education makes other demands. The volume under consideration is aimed to help the medical student learn what he "needs" to know. In a way it is just as dated as the older, more formidable works, though it achieves its purpose as well. For modern use by medical students, particularly to illustrate the proper appearance of dissections, it should be most useful.

F. N. Low

An Atlas of Radiographic Anatomy.

By Isadore Meschan; with the assistance of R. M. F. Farrer-Meschan. W. B. Saunders Company; London, Philadelphia. $15.00. xi + 593 pp.; ill. 1951.

This book was written in response to a growing interest in diagnostic radiology. It is admirably designed, being a presentation of its subject both simple and clear. Introductory chapters on the fundamentals of radiographic technique and skeletal radiography in general are followed by 14 chapters on topographical radiology. These are comprehensive, and include various techniques used for visualizing the soft parts. A typical presentation includes on facing pages a line drawing of the patient's position, the actual radiograph, and a labeled line drawing of the radiograph. Anatomical drawings are interspersed as text figures. The text itself collates well with the illustrations. The index is adequate. Reference to source material is rare, but this is not a critical shortcoming, since the whole presentation is remarkably self-sustaining. This text represents the painstaking work of experts. Pedagogical skill is evident throughout, and it should rise to an enviable position in its field.

F. N. Low

Micro-Arteriography *and other Radiological Techniques Employed in Biological Research.*

By Alfred E. Barclay. Charles C Thomas, Springfield, Ill. $6.75. xiii + 102 pp. + 2 folding pl.; text ill. 1951.

The preparation of this volume was undertaken by A. E. Barclay on the persuasion of interested friends and was completed posthumously by them. It is essentially a technical manual covering a little known and largely undeveloped field. It was designed primarily to guide future scientists who may take up the work. However, the vascular pattern of certain organs, for example, the kidney, is described and analyzed in considerable detail. The style is chatty and personal. There is an index and a short bibliography. The book is well printed on fine paper with good illustrations, some of which are large

folding plates. It should be valuable to anyone interested in its field.

F. N. Low

CONNECTIVE TISSUES. *Transactions of the Second Conference, May 24–25, 1951, New York.*

Edited by Charles Ragan. Josiah Macy, Jr., Foundation, New York. $3.50. 190 pp.; ill. 1952.

This is a most remarkable volume, interesting through its revealing frankness as well as its excellent scientific content. A brief introduction by Dr. Freemont-Smith states to perfection the general plan and purpose of the Josiah Macy, Jr., Foundation Conference Program. Thirteen groups function under this program, the present volume reporting the 2nd Conference of the group whose speciality is the connective tissues. Papers are presented before this conference group, consisting of a chairman and 15 members. Invited guests may bring the total attendance to not more than 25 persons. Discussion is encouraged at any point in the presentation and is recorded verbatim along with the text of the paper. Five fundamental aspects of our knowledge of connective tissues were discussed in this conference, as follows: Some Functional Considerations of Ground Substance of Connective Tissues (I. Gersh); Chemical Morphology of Elastic Fibers (A. I. Lansing); Pain Mechanisms in Connective Tissues (J. Travell); Repair Processes in Connective Tissues (K. R. Porter) and Regression of Scar Tissue (T. G. Morrione).

Keith Porter's presentation should be particularly interesting to histologists and pathologists, since it deals primarily with the origin of collagen from fibroblasts, as revealed by electron microscopic examination of tissue culture cells. The sequence of events occurring at levels beyond the resolving power of the light microscope provides interesting information about the heretofore puzzling relationship between collagen and fibroblasts. Gersh's account of the relationship of ground substance to growth, tumor formation, and endocrine activity represents a most interesting and provocative correlation of separate scientific fields.

The Macy Foundation should be congratulated for having presented this conference to the scientific public in such excellent form. The account is revealing, clear, authoritative, and delightfully informal. May there be many more similar volumes! Recommendation is made without reservation.

F. N. Low

THE GROWTH, REPLACEMENT, AND TYPES OF HAIR. *Ann. N. Y. Acad. Sci., Vol. 53, Art. 3.*

By J. B. Hamilton, A. E. Light, and 24 other authors. New York Academy of Sciences, New York. $4.00 (paper). Pp. 461–752; ill. 1951.

This volume is a collection of 27 papers loosely organized around the subject of hair. There is a considerable review of the literature and some new material. For anyone interested in hair or hair products, it is a necessary reference work, but for the general biologist it contains probably little of interest. Outstanding papers are those dealing with keratinization and to a lesser extent those dealing with hair growth.

A more complete introduction could have been written to point out the philosophy behind such a collection of papers and to organize the diverse material into a more unified whole. A notable lack is the omission of any work dealing with the hair follicle in its relation to the skin, sebaceous glands, and pigmentation. Indeed, the hair is a broad subject to cover, but one or two papers on functional relationships (in addition to Herrington's on the thermal relations) would have added greatly to the general biological interest and would have avoided the incorrect impression that the hair is an isolated and independent entity.

These papers were presented at a conference, and there was ample discussion which involved physiological and other aspects. Publication of some of this discussion would have improved the volume. In conclusion it should be reiterated that there were some outstanding papers, but that the volume as a whole is merely a collection of diverse articles dealing with the hair.

HERMAN B. CHASE

ANIMAL PHYSIOLOGY

ANNUAL REVIEW OF PHYSIOLOGY. *Vol. XIII.*

Editor: Victor E. Hall; Associate Editors: Jefferson M. Crismon and Arthur C. Giese. Annual Reviews, Stanford, California. $6.00. xii + 457 pp. + 2 pl. 1951.

Volume XIII of the *Annual Review of Physiology* has as its Prefatory Chapter an interesting account of his personal experiences and observations by C. J. Wiggers, Physiology from 1900 to 1920: Incidents, Accidents, and Advances. Seventeen review articles, their titles and authors listed below, make up this issue: Permeability (H. B. Steinbach); Biological Effects of Radiations (H. J. Curtis); Developmental Physiology (J. Runnstrom and T. Gustafson); Physiological Effects of Heat and Cold (R. Grant); Muscle (D. K. Hill); Digestive System (E. S. Masset); Liver (J. W. Wilson); Peripheral Circulation (K. G. Wakim); Heart (H. B. Burchell); Respiration (J. S. Gray and F. S. Grodins); Kidney (E. E. Selkurt); Conduction and Transmission of Nerve Impulses (T. H. Bullock);

Somatic Functions of the Nervous System (G. Moruzzi); Electrical Activity of the Brain (H. J. Gastaut); Metabolic Functions of the Endocrine Glands (J. A. Russell); Physiology of Reproduction (J. E. Markee); Blood Volume (M. I. Gregersen).

Only the last review article treats a period of greater than 2 years. The reviews of peripheral circulation, heart, and kidney indicate the usual interest in these fields, as evidenced by bibliographies of 250 to 300 references each. The article on reproduction heads the list, however, with 493 citations for the one-year period, June 1949–June 1950. The most extensive review, as measured by bibliographical references, was that on the Electrical Activity of the Brain, which cited 536 articles from the period June 1948–June 1950.

JOHN K. HAMPTON, JR.

INSECT PHYSIOLOGY. *Methuen Monograph on Biological Subjects. 4th Edition.*

By V. B. Wigglesworth. John Wiley & Sons, New York; Methuen & Co., London. $1.25. x + 134 pp.; ill. 1950.

This is an exact reprinting of the *first* edition of 1934 (*Q.R.B.* 10: 228. 1935). Discussion and references are therefore in no way up to date.

A COURSE OF PRACTICAL PHYSIOLOGY FOR AGRICULTURAL STUDENTS.

By E. T. Halnan and J. Hammond. Cambridge University Press, New York and London. $1.50. 124 pp. 1950.

An elementary manual for agricultural students.

THE PHYSIOLOGY AND PATHOLOGY OF HEMOSTASIS.

By Armand J. Quick. Lea & Febiger, Philadelphia. $4.00. 188 pp.; ill. 1951.

This small monograph summarizes the work and the views of the author on hemostasis and coagulation of the blood. In the first part, after a preliminary historical sketch, Quick discusses the various factors concerned in coagulation and the manner in which he believes they interact. Quick has been an active contributor in this field during the past 15 years. Among his major observations may be mentioned the presence in plasma of a precursor of thromboplastin, the role of the platelets in activating this substance and accelerating the production of thrombin in an autocatalytic "chain" type of reaction, the existence of an additional "labile factor" in plasma which with thromboplastin and calcium is essential in the conversion of prothrombin to thrombin, and the presence in plasma of a relatively stable precursor of prothrombin which is as yet inadequately characterized. This work, with that of others, has necessitated radical alterations of the old "classical" (Morawitz) theory of coagulation, and Quick has proposed a new and more adequate theory. It is striking that in his scheme inhibitors receive but little—perhaps too little—consideration. This section is brief yet comprehensive, it is written with exceptional clarity, and it can be followed easily by the average reader. The latter should remember that this whole subject is still under active study and that some of Quick's conclusions and theories are vigorously questioned by other investigators in the field.

There follows an adequate yet brief discussion of hemorrhagic diseases and their diagnosis and treatment. Venous thrombosis is similarly discussed with brief reference to treatment with anticoagulants. Bibliographies are included.

The last 80 pages are devoted to detailed directions for pertinent laboratory procedures. These include the simpler tests that are practicable for clinical use and also methods for the assay of the various coagulation factors, the use of which will be restricted largely to the research laboratory. Stress is naturally laid on the author's "one stage" test of the prothrombin time, a simple accurate procedure which is widely used and which from the practical clinical standpoint may be regarded as Quick's most important single contribution. Reading this section will not create a competent technician, but those who have had adequate practice in these technics will find it very useful.

Quick's book is welcome and timely and is recommended to all who wish a brief, clear presentation of the subject.

PAUL W. CLOUGH

ENDOCRINOLOGY—*the Glands and their Function. Revised and enlarged edition.*

By R. G. Hoskins. W. W. Norton & Co., New York. $5.50. 402 pp. + 12 pl.; text ill. 1950.

This highly readable, popular presentation of the hormones and their roles in metabolism has been revised without general alteration of the plan or style of the book (see *Q.R.B.*, 16: 500. 1941). However, the date of the revision was such that much important new work could not be included. For example, there is no mention of the isolation of the growth hormone of the anterior pituitary, or of the specific inhibitory action of anterior pituitary extract on the hexokinase reaction that leads to insulin antagonism, as shown by Colowick and Cori. Another example of the action of a hormone by means of its influence upon a specific

enzyme, namely, the action of epinephrine upon phosphorylase, is not to be found. Discussion of the nature and action of cortisone and of ACTH is exceedingly tentative and brief. Thus the work, for all its excellent qualities, is already due to receive further revision.

BENTLEY GLASS

THYROID FUNCTION AND ITS POSSIBLE ROLE IN VASCULAR DEGENERATION. *Publication No. 108, American Lecture Series. A Monograph In American Lectures In Circulation.*

By William B. Kountz; edited by Irvine H. Page and A. C. Corcoran. Charles C Thomas; Springfield, Ill. $2.25. viii + 62 pp.; ill. 1951.

COMPARATIVE PHYSIOLOGY OF THE THYROID AND PARATHYROID GLANDS. *Publication No. 118, American Lecture Series. A Monograph In American Lectures in Endocrinology.*

By Walter Fleischmann; edited by Willard O. Thompson. Charles C Thomas; Springfield, Ill. $2.25. vi + 78 pp. 1951.

These two monographs of the American Lecture Series like previous ones, are to be highly recommended for teachers in biology and medicine as well as for those who desire a general review of fields of work in which they have little acquaintance. The treatise by Walter Fleischmann on the Comparative Physiology of the Thyroid and Parathyroid Glands is exceptionally good. It discusses the storage of radioactive iodine and the general physiological and biochemical mechanisms involved in thyroid activity during the various stages of development of fish, amphibia, reptiles, birds, and mammals. Kountz' treatise deals with the possible relationship of thyroid activity to the development of arteriosclerosis. Data from both experimental study and clinical observations are presented. Kountz, like others, believes that there are at least two, and perhaps more, separate and independent types of degenerative changes which occur in the blood vessels of a person with arteriosclerosis. It is held that changes in the medial part of the vessels are frequently found in individuals with elevated blood cholesterol or disturbed fat metabolism. This type of disturbance is commonly associated with hypothyroidism.

DAVID B. TYLER

METABOLISM AND FUNCTION IN NERVOUS TISSUE. *Biochemical Society Symposia No. 8.*

Organized and edited by R. T. Williams. Cambridge, at the University Press. 12s. 6d. (paper). vi + 102 pp.; ill. 1952.

This volume is a compilation of the papers presented at a symposium held at the London School of Hygiene and Tropical Medicine in 1951. The subjects presented are: Introduction (R. A. Peters); Carbohydrate Metabolism in Nervous Tissue (R. V. Coxon); Glutamic Acid and its Relation to the Nervous System (H. Weil-Malherbe); Phosphates and Nucleotides of the Central Nervous System (H. McIlwain); Lipids of the Central Nervous System (G. H. Sloane-Stanley); Brain Metabolism and Cerebral Function (D. Richter); Biochemical Aspects of the Transport of Ions by Nervous Tissue (R. E. Davies and H. A. Krebs); The Use of Isotopes in the Study of the Metabolism of the Nervous System (R. M. C. Dawson). The papers adequately describe the current condition of research upon the fundamental biochemistry of brain tissue.

R. VAN REEN

THE KIDNEY. *Structure and Function in Health and Disease.*

By Homer W. Smith. Oxford University Press, New York. $12.50. xxii + 1049 pp. + 4 pl.; text ill. 1951.

This most impressive summary of contemporary studies on renal physiology will be invaluable to serious students of the kidney. The brilliant flowering of precise analysis of renal function which has taken place during the last 20 years has been developed in no small part by the author and his colleagues. This volume now synthesizes into an orderly structure what seems to be definite, evaluates what is suggestive, and assembles the odd pieces which still seem to fit nowhere. Altogether a bibliography of 2300 papers is discussed, the great majority of which were published within the last two decades. Historical backgrounds are indicated relatively briefly. The book is based to some extent on the author's 1937 monograph on the kidney, but the present volume is much more extensive. The text is composed of 4 sections. Part I deals with the general evidence for the accepted filtration-reabsorption-secretion theory of renal function; Part II, with the excretion of strong electrolytes, and with acid-base and water balances; Part III, with physiological factors which affect kidney function, and the comparative physiology of the kidney; Part IV, with renal function in disease and unusual situations. The book would have been improved by a more comprehensive index and a more complete listing of symbols in one place. It is not free from contradictions, for example, in the chapter on adrenal relationships to kidney function; but this is hardly surprising in such a rapidly growing and complex field, and in spite of any such defects the book will be immensely useful. It is a book which records real progress in a subject, a book to which physiology as a field is profoundly indebted.

EVELYN HOWARD

RENAL FUNCTION STUDIES IN THE RAT.

By Fernand Martel, Madeleine Wang, and Rosaire Gingras. Les Presses Universitaires Laval, Quebec. $4.00 (paper). ii + 76 pp. 1951.

Hexahomoserine (DL-α-amino-ε-hydroxycaproic acid) is known to be a lysine antagonist and to produce anemia in rats and swine. In addition, it produces in rats a marked increase in the renal excretion of creatinine. This monograph is a report on an investigation of the mechanism of the increased creatinine excretion. The authors have applied the classical methods of renal physiology to the problem, and have made studies of the inulin and creatinine clearances and of the maximal excretion of para-aminohippurate before and after administration of hexahomoserine. It is concluded that this compound increases the tubular secretion of creatinine and has no significant effect on the rate of formation of glomerular fluid or on the tubular "mass." Numerous tables of data are included.

F. CHINARD

NEW MEANS OF STUDYING COLOR BLINDNESS AND NORMAL FOVEAL COLOR VISION: *With Some Results and Their Genetical Implications.*

By Gordon L. Walls and Ravenna W. Mathews. University of California Press, Berkeley and Los Angeles. $2.50. iv + 172 pp. 1951.

This is a research monograph dealing with normal and defective color vision. The text is divided into 3 major sections. The first part reviews critically certain aspects of the literature on normal and defective color vision; the second describes methods the authors have developed for testing color vision; the third presents results obtained with 50 color-normal and 87 color-defective subjects.

In their review of the literature, Walls and Matthews have suggested some novel reinterpretations of what is now regarded as classical literature. Color vision scientists will especially be interested in their conclusion that all of the visual phenomena associated with Maxwell's spot are unrelated to pigmentation in the macula lutea. Equally novel is their conclusion that phenomena associated with Maxwell's spot are explained by differences in the distribution of receptor elements in the retina. On this basis they have developed a special filter test which, they claim, distinguishes between the two major types of color deficiency. The theoretical implications of their findings are fully discussed in physiological and genetic terms.

It is hard to know whether Walls and Matthews really have something true or not. If what they claim is right, they have made an extremely important contribution to this area of research. But since they are fostering some unorthodox ideas, and since they tend to be a little glib and caustic in their style of writing, it is difficult to be entirely sympathetic. Whatever else one may say, there is no doubt that this is a monograph no scientist studying color vision can afford to miss.

A. CHAPANIS

MARSHALL'S PHYSIOLOGY OF REPRODUCTION. *Volume II. Third Edition.*

Edited by A. S. Parkes. Longmans, Green, and Company, London, New York, and Toronto. 150s.; $27.50 (2 vols.). xx + 880 pp.; ill. 1952.

The first edition of *The Physiology of Reproduction*, which appeared in 1910, contained virtually everything then known about the physiological processes involved in reproduction. A second edition was prepared after the First World War and appeared in 1922. By 1935 it was clear that a third edition should be prepared. It was also apparent that the increase of knowledge had placed beyond the powers of a single writer a book of the scope achieved in 1910 and maintained in 1922. Marshall accordingly made arrangements for his book to be revised by some 14 different contributors, under the editorship of A. S. Parkes. Completion of the third edition was delayed by the Second World War. Further delays, resulting in part from general post-war complications, held up publication of Volume II until the present time. Volume I has not yet been published. Nearly 20 years have thus elapsed since the need for a third revision became apparent. Marshall did not live to see this edition in print, having died suddenly in February, 1949.

Volume II deals with embryonic and fetal development and physiology, lactation, fertility, sex determination, and the life cycle. Much of the older material has of necessity been omitted. On the other hand, very recent material is not included, primarily because of the long lag in publication of a book of this size under existing conditions. Evaluation of the work should take into account the fact that, as a whole, it embraces the accumulated knowledge of about 2,000 years, and that the present edition alone bridges a gap of nearly 30 years since the previous edition, needless to say, a 30 years tremendously productive in the field of reproductive physiology. It does not seem at all presumptuous on the part of the editor to express the hope that this will remain a standard work for a decade or more to come.

MAX KRAUSS

ANIMAL NUTRITION

HANDBOOK OF NUTRITION. *A Symposium Prepared under the Auspices of the Council on Foods and Nutrition of the American Medical Association. 2nd Edition.*

Council on Foods and Nutrition, American Medical Association. Blakiston Co., Philadelphia, New York, and Toronto. $4.50. xx + 717 pp. 1951.

Prepared under the auspices of the Council on Foods and Nutrition of the American Medical Association, this handbook is the combined contribution of many of the country's outstanding nutritionists, biochemists, and medical scientists. The 28 chapters are grouped into four parts as follows: Individual Nutrients; Nutritional Needs; Nutritional Deficiencies; and Foods and Their Nutritional Qualities.

While it is obviously impossible in the handbook to cover completely all phases of nutrition, the highlights of a variety of subjects of fundamental interest to the nutritionist and physician are presented. The sections devoted to nutritional needs and deficiencies should be of particular interest to those responsible for clinical aspects of nutrition. Considerable attention is given to the recommended dietary allowances and energy requirements of the adult, the feeding of healthy infants and children, nutritional requirements during pregnancy and lactation, problems of geriatric medicine, and nutritional needs in illness and disease. Other special aspects, such as caloric undernutrition, starvation, and foods for emergencies, are also reviewed.

R. Van Reen

Methods of Vitamin Assay. *Second Edition, revised and supplemented.*

Prepared and Edited by The Association of Vitamin Chemists. Interscience Publishers, New York and London. $5.50. xviii + 301 pp. 1951.

This very useful manual in vitamin methodology, which originally appeared in 1947, has been somewhat expanded. It now includes analytical procedures for several members of the vitamin B complex for which procedures were not described in the first edition. These include methods for pantothenic acid, pyridoxine, folic acid, biotin, vitamin B_{12}, and a chemical analysis for niacin.

Revisions have also been made in methods already described in the original edition, in order to incorporate information from the current literature, as well as changes suggested by users of the book. While such vitamins as D, E, and K, p-aminobenzoic acid, inositol, and choline are still not provided with specific assay methods, the chapter dealing with these vitamins has been extended to provide the analyst with a basis for selecting a suitable procedure. The format and style of the first edition has been maintained.

Alvin Nason

Nutrition in Ophthalmology. *Nutrition Monograph Series, No. 1.*

By John J. Stern. National Vitamin Foundation, New York. $1.50 (paper). iv + 137 pp. 1950.

This is a fluent and readable review addressed to both ophthalmologists and nutritionists, and surveying the recent literature on the possible ocular symptoms and diseases attributable to nutritional disturbances. The coverage of the literature is wide, and the critical analysis in the text, on the whole, judicious. For the most part the biochemical mechanisms of nutritional disturbances are not dealt with, the emphasis being on the signs and symptoms of the various diseases that are discussed. The author includes a good many disease syndromes the nutritional etiology of which is highly questionable, but which have been attributed to nutritional disturbances by some authors. He gives the arguments for and against nutritional etiology in these debatable fields, and adheres to the generally conservative point of view in his judgments. Stern points out that ophthalmologists, on the whole, have been less aware of the possible nutritional basis of ocular diseases than have specialists in other fields. It is to be hoped that this monograph will be useful in arousing their interest.

Jonas S. Friedenwald

BIOPHYSICS

Ultraviolet Radiation.

By Lewis R. Koller. John Wiley & Sons, New York; Chapman & Hall, London. $6.50. x + 270 pp.; ill. 1952.

The biologist who seeks information about the physical aspects of ultraviolet radiation will find this volume an excellent source. Following a brief introduction of an historical nature, 3 chapters are devoted to the quantity and quality of ultraviolet radiation derived from arcs, incandescent sources, andsolar radiation. Two chapters on transmission and reflection are followed by 1 on the applications and effects of ultraviolet and 1 on the various detectors employed for measurements of energy in this region of the spectrum. Monochromators as such are not discussed, but filters of various sorts are considered thoroughly, and this information will provide the means for the isolation of certain regions of the spectrum. Biological data are scanty, and restricted to erythymal and bactericidal effects and to the production of vitamin D; but since there is a good deal of published data on the biological effects of ultraviolet radiation, the author has wisely refrained from entering a field which is still being explored and which is, consequently, still unsettled.

C. P. Swanson

BIOCHEMISTRY

ANNUAL REVIEW OF BIOCHEMISTRY. *Volume 20. Editor, J. Murray Luck; Associate Editors, Hubert S. Loring and Gordon Mackinney. Annual Reviews, Stanford, Calif.* $6.00. x + 648 pp. 1951.

These reviews continue their previous high standards of excellence, and in addition the preface to this volume contains some interesting remarks by the editors on their general policy of bibliographic citation. The subjects reviewed are as follows: Biological Oxidations (Wurmser); Nonoxidative, Nonproteolytic Enzymes (Frisell & Hellerman); Carbohydrate Chemistry (Fischer & MacDonald); The Polyuronides (Hinton); The Chemistry of Amino Acids and Proteins (Bailey & Sanger); X-ray Crystallographic Studies of Compounds of Biological Interest (Corey); Nucleic Acids, Purines, and Pyrimidines (Baddiley); Lipid Metabolism (Gurin & Crandall); The Metabolism of Protiens and Amino Acids (Borsook & Deasy); Biochemistry of Steroids (Leberman & Dobriner); Fat Soluble Vitamins (Dam); Nutrition (Almquist); Biochemistry of Cancer (Brues & Barron); Biochemistry of Antibiotics (Peck & Lyons); Immunochemistry (Mayer); The Metabolism of Drugs and Toxic Substances (Williams); Biochemical Genetics (Horowitz & Mitchell); Biochemistry of Natural Pigments (Seshadri); Carbohydrate Metabolism (Colowick & Kaplan); Water Soluble Vitamins (Emerson & Folkers).

PHYSICAL BIOCHEMISTRY. *2nd Edition. By Henry B. Bull. John Wiley & Sons, New York; Chapman & Hall, London.* $5.75. x + 355 pp. 1951.

The second edition of *Physical Biochemistry* has undergone a drastic revision compared to the original edition, which appeared 8 years ago. Approximately two-thirds of the book has been rewritten and the result is a markedly improved volume. Virtually every chapter has been reworked with accompanying deletions and additions. One of the most prominent changes has been the addition of questions and answers at the end of each chapter. As in the first edition, the material is kept simple and compact, almost to the point of an outline, with emphasis on the fundamental points. The book has been designed primarily for students of biochemistry and physiology, and for this purpose the choice of topics to make up the various chapters has been excellent. The discussions dealing with reaction kinetics, electromotive force cells, and acids and bases are particularly good. This edition is strongly recommended for an elementary introduction to certain fields of physical chemistry which are of special interest to the biologist.

ALVIN NASON

EXPERIMENTS IN BIOCHEMISTRY. *By Max S. Dunn and William Drell. McGraw-Hill Book Company, New York.* $5.00. vii + 197 pp. + 46 experiment data sheets; text ill. 1951.

This is no clinical laboratory manual, but rather, a guide and reference book for introducing students to the problems, methods, and literature of biochemical research. The first half of the book is devoted to a series of experiments that will acquaint the beginning biochemistry student with the techniques of the synthesis, isolation, purification, and characterization of biological materials. The experiments on the identification of amino acid and carbohydrate mixtures are particularly helpful. Perhaps a word or two about the use of the technique of paper chromatography in the separation of these two groups of compounds would have been in order; however, paper chromatography is included in regard to the separation and identification of purines and pyrimidines. Considerable attention is given to the quantitative determination of biological compounds. The laboratory directions are complete, and the historical and biochemical background of the various experiments most helpful. The last half of the book is given over the description of apparatus, reagents and supplies, techniques (distillation, melting point, pH, photometry, polarimetry, etc.) and an extensive bibliography on biochemical methods. Data sheets are furnished for the experiments and will demonstrate to the student the value of adequate experimental notes.

G. R. NOGGLE

CHEMISTRY OF MUSCULAR CONTRACTION. *2nd Edition, revised and enlarged. By A. Szent-Györgyi. Academic Press, New York.* $4.50. x + 162 pp.; ill. 1951.

The first edition of this book was fascinating to some, irritating to others, but certainly stimulating to all. This second and completely revised edition may arouse still stronger emotions in those who plow the fields of muscle chemistry and physiology. It is largely a summary of the experimental work, of the working hypotheses, and of the speculations of Szent-Györgi and his collaborators, but with due consideration for the contributions of others.

The first 9 chapters are essentially descriptive and cover the following topics: structure of muscle (with numerous reproductions of electron photomicrographs), whole muscle, physical and chemical disintegration of muscle, myosin and its properties, actin and its several transformations, and actomyosin and its constituents in muscle. Chapters X and XI contain a very useful summary of the application of thermodynamics to muscle and a clear statement of the possible sig-

nificance of ATP to muscular contraction. The standard free energy of ATP is higher by approximately 11,000 calories than the standard free energy of ADP. Szent-Györgi points out that, in order for this difference of standard free energies to be of use in mechanical work, ATP must be directly and structurally involved in the mechanism of contraction. Hydrolysis of ATP to ADP without such intimate connection could not make the free energy difference "available" for contraction. A subsequent chapter describes the contraction cycle and the author's theory on the subject. He carefully points out that this is a theory and that he has been wrong before. Differences and similarities of smooth muscle and heart muscle are then discussed. There follow a brief presentation of his "continuum theory," and a chapter on water and viruses. The last is highly speculative and includes a suggestion that the poliomyelitis virus may be a degenerated form of actin or some other analogous protein. Finally, there is an appendix on certain important experimental procedures.

This is a provocative book. As such, it provides much of interest to all biologists and will be invaluable as a stimulus to further work.

F. CHINARD

PROTEINS AND ENZYMES. *Lane Medical Lectures. Medical Sciences, Vol. VI.*

By Kaj Ulrik Linderstrom. Stanford University Press, Stanford. $3.00 (paper). vii + 115 pp.; ill. 1952.

Somewhat over 20 years' work of the Chemical Division of the Carlsberg Laboratory is summarized in this series of lectures. In the first lecture, the author describes some of the many micromethods which have been developed by him, and indicates how these methods have aided in the solution of specific problems. The second lecture deals with the distribution of enzymes in cells, the third and fourth concern the enzymatic breakdown of proteins, and the fifth, the biological synthesis of proteins.

Throughout, the discussion is stimulating and many of the the problems in protein synthesis are examined in a critical way with useful suggestions as to the direction of future work.

L. J. MULLINS

VITAMINS, COENZYMES AND NUCLEOTIDES. *Nieuwland Lectures, Vol. III, 1948.*

By Alexander R. Todd. University of Notre Dame, Notre Dame, Indiana. Paper. 53 pp.; ill. 1949.

Although now somewhat dated by recent developments in the rapidly advancing field of polynucleotide studies and phosphorylative mechanisms (see *Phosphorus Metabolism*, Vols. I and II, of which the first volume was reviewed in *Q.R.B.*, 27: 326), this series of 3 lectures by the eminent British biochemist remains as fine an introduction to the topics of Vitamins and Coenzymes, Nucleoside Synthesis, and Phosphorylation and Nucleotide Synthesis as the novice in these subjects could wish. The exposition is more than simply clear; it penetrates to the heart of the significant relationships between biochemical substances of the utmost importance.

BENTLEY GLASS

VITAMINS AND HORMONES. *Advances in Research and Applications. Volume VIII.*

Edited by Robert S. Harris and Kenneth V. Thimann. Academic Press, New York. $7.80. xi + 342 pp.; ill. 1950.

Volume VIII of *Vitamins and Hormones* is divided into 4 contributions on vitamins and 4 on hormones, with little evidence of overlap between these disciplines. Excellent sketches of historical and background work are provided in the article on Relaxin (Hisaw and Zarrow) and in Zucker's article on Vitamin B_{12}. The former is timely in view of the decided revival of interest in that hormone, so clearly bound up with connective tissue behavior. The history of B_{12} is a chapter of the greatest complexity. This vitamin is unique in being absent in the higher plants and in yeasts, and is chemically remarkable for its content of cobalt. Pioneers in the field give a good account of the controversial antistiffness factor; and another pioneer, R. Courrier, has reviewed the literature of estrogen and progesterone antagonism and synergism, a topic with important ramifications in other branches of endocrinology. R. H. Stehle here completes his review of the hormones of the posterior pituitary, begun in the previous volume, with an account of their actions on the uterus and other organs. Other contents: Pyridoxine and Fat Metabolism (Sherman); Vitamins and Metabolism in *Neurospora* (Mitchell); and Steroid Configuration (Shoppee).

H. R. CATCHPOLE

COLLOID SCIENCE.

By James W. McBain. D. C. Heath & Co., Boston. Text Edition: $6.00; *Trade Edition (distributed except in the British Commonwealth by Reinhold Publishing Corp., New York):* $8.00. x + 450 pp.; ill. 1950.

This book represents an important addition to student textbooks in the field of colloid chemistry. It is the first book that covers, in addition to classical colloid chemistry, most of the modern information about

colloidal electrolytes, ion exchange, fiber structure and related topics, in such a way as to suggest many possible applications of this information to biological problems.

L. J. MULLINS

GUIDE TO THE LITERATURE ON COLLAGEN.

By Rubin Borasky. Eastern Regional Research Laboratory, U. S. Department of Agriculture, Philadelphia. Free upon request (paper). iii + 135 pp. 1950.

A bibliography of 1008 references on collagen, and such related topics as gelatin, glue, elastin, reticulin, connective tissue, etc., classified under the headings of Biology, Biophysics, and Chemistry, and covering the period from 1820 through 1949. Both Author and Subject Indexes are provided.

AN INTRODUCTION TO ORGANIC CHEMISTRY. *7th Edition.*

By the late Alexander Lowy and Benjamin Harrow; revision by Benjamin Harrow and Percy M. Apfelbaum. John Wiley & Sons, New York; Chapman & Hall, London. $5.00. xiv + 480 pp. + 3 folding charts. 1951.

In the preface to the first edition of this book, the authors stated that "they desired to embody in the work material which could be satisfactorily treated in a course in which the theory of organic chemistry is covered in two semesters (two hours a week)." They have perhaps succeeded in doing this, with the net result that in many places there is a very spotty presentation of facts. In the case of the biochemical material, with which the reviewer is most familiar, a mass of formulae, useless in themselves, is presented for what seems an interminable number of pages. However, there are some things to recommend this book, which has now reached its seventh edition. There is a brief review of common type reactions, a number of interesting charts, and a chapter on organic nomenclature, all of which should provide the beginning student with a great deal of help. It is, of course, definitely not the book for the class of students whose basic interest lies in the direction of organic chemistry.

MICROBIOLOGY

GRUNDRISS DER MIKROBIOLOGIE. *Zweite Auflage.*

By Dr. August Rippel-Baldes. Springer-Verlag, Berlin, Gottingen, and Heidelberg. DM. 36.00. viii + 401 pp.; ill. 1952.

This revised edition of a general textbook of microbiology is designed to acquaint students and investigators in certain allied sciences, e.g., general biology, agriculture, and chemistry, with the principles and phenomena of microbiology. In its broad but not sketchy approach, the book offers an excellent general survey of the fields of bacteriology and mycology, placing special emphasis on physiology and ecology. In keeping with its general biological approach, the book considers the medical aspects of microbiology only very briefly. Systematics is also kept to a minimum and all aspects are considered for microorganisms in general; however, citations for experimental data obtained with specific organisms are given. Many references throughout the text cover representative examples in the literature up to 1950, the references to German papers being more numerous than those to papers published abroad. Although some valuable recent publications are thus neglected, this omission is compensated for by the fact that many of the references cited are to publications that are often not quoted in the American literature. As has been customary for the prewar publications of the Springer-Verlag, the make-up of the book and the illustrations are of an unusually high standard.

WERNER BRAUN

BACTERIA.

By K. A. Bisset, assisted by F. W. Moore. The Williams and Wilkins Company, Baltimore. $4.00. viii + 123 pp. + folding chart; text ill. 1952.

This thin book is recommended only to those seeking a concise statement of the author's views of the morphology, structure, and taxonomy of bacteria. Within the compass of 111 pages of text, the author has not attempted to justify his views of the natural history of bacteria nor to discuss permissible alternatives to his views. For these reasons, since the concepts presented are often novel, and more seriously, because a number are unacceptable to other investigators in the complex fields of bacterial cytology and taxonomy, this book cannot be considered to contribute to the further education of the experimental bacteriologist. These deficiencies would also preclude the use of the book as a text for the instruction of the novice in bacteriology. This prohibition is reinforced by the presence of an unfortunate number of incomplete statements and errors of fact which the beginning student would not be in a position to discover for himself. As examples of such errors, and limiting ourselves to the chapter on bacteriophage, are fig. 37, which shows bacteriophages possessing tails adsorbed head-first to the surface of a host bacterium, the statement that the growth of some phages may be at the surface of the host, and that

phage multiplication sometimes takes place outside of the bacterium.

CARL LAMANNA

DIAGNOSTIC BACTERIOLOGY. *A Textbook for the Isolation and Identification of Pathogenic Bacteria. Fourth Edition.*

By Isabelle Gilbert Schaub and M. Kathleen Foley. The C. V. Mosby Company, St. Louis. $4.50. 356 pp. 1952.

The present text represents a practical manual for the isolation and identification of pathogenic bacteria as well as other pathogenic microorganisms. It appears to have been very carefully revised from previous editions so as to be of maximum usefulness. Although references to the literature are relatively few, it is apparent that the authors have given careful consideration to the results of other workers. Serology as well as the determination of the sensitivity of bacteria to antibiotics receive thorough attention. The book will merit careful attention from those engaged in medical bacteriology.

WALTER C. TOBIE

LABORATORY MANUAL FOR GENERAL BACTERIOLOGY. *Fourth Edition.*

Compiled by George L. Peltier, Carl E. Georgi, and Lawrence F. Lindgren. John Wiley & Sons, New York; Chapman & Hall, London. $3.50. (paper). viii + 293 pp.; ill. 1952.

This manual has a spiral binder, and the text appears usually on one side and less often on two sides of the paper. As a pleasant change from most such manuals, it is in printed type and not in type-script. Despite the title, the coverage is not limited to bacteriology in a narrow sense, since yeasts and molds are also considered. The occasional figures are well reproduced. Some 60 exercises are included, some in the theoretical and some in the applied phases of microbiology. At the end of each exercise, references to standard textbooks are provided. The general impression given is that of a rather superior work which deserves careful consideration from those interested in planning a beginning course in bacteriology and microbiology.

WALTER C. TOBIE

DETERMINATIVE BACTERIOLOGY LABORATORY MANUAL.

By Thomas H. Lord. Burgess Publishing Company, Minneapolis. $2.25 (paper). ii + 63 pp. + descriptive charts; ill. 1952.

This is another well-printed spiral-binder manual. It is a bit unusual in scope, dealing with the identification of unknown bacteria. As such, it might be applicable to a second or even a third course in bacteriology. It deals well with those families of bacteria which will ordinarily be encountered in the usual course in medical or technical bacteriology, and leaves esoteric and obscure groups to the advanced specialists, as is quite proper. The last 20 pages or so are tabular forms designed to be filled in with the morphological, staining, colonial, and biochemical characteristics of the unknown microorganisms encountered. The manual is a valuable one for training beginners in determinative and taxonomic bacteriology.

WALTER C. TOBIE

PARASITOLOGY

ZOOPARASITEN UND DIE REAKTIONEN IHRER WIRTSTIERE.

By Prof. Dr. Otto Pflugfelder. Gustav Fischer, Jena. DM. 12.00. viii + 198 pp.; ill. 1950.

Differing from the usual work on zooparasitology, this small but useful book concerns itself wholly with the reactions of the host to the presence of the parasite, including cell and tissue changes and immune responses. Wasting no space on stale repetitions of parasite morphology, the book plunges at once into the subject, taking up the parasitic groups in phylogenetic sequence. The groups considered are the Protozoa, Trematoda, Cestoda, Nematoda, Acanthocephala, Annelida, Arthropoda, and Mollusca (glochidia). The changes evoked in the host cells and tissues by parasites of each of these groups is described with abundant illustrations. A second more general part takes up phagocytosis, and other cell responses of the host to the presence of the parasite, and the production of immune bodies. There is a bibliography of 28 pages, practically all prior to 1940, and a subject and author index.

L. H. HYMAN

A LABORATORY MANUAL IN ANIMAL PARASITOLOGY. *With Special Reference to the Animal Parasites of Man. Revised Edition.*

By H. W. Manter. Burgess Publishing Company, Minneapolis. $2.50. x + 121 pp.; ill. 1950.

This manual is intended to introduce the student to general parasitology through the study of various types of animal parasites. It has been revised to include, in tabular form, data on the parasites of man and several new illustrations. Some of the laboratory exercises also have been rewritten. Detailed directions are given for the laboratory study of representatives of

the main parasite groups, including the arthropods, as well as a brief section on techniques. It is well written and illustrated, and the material is presented in a clear, concise manner. Emphasis is placed on the general aspects of parasitology, including animal parasites as well as those of humans. Of especial value are the bibliographic aids and the list of reference books. The manual would be of use to anyone interested in general parasitology or concerned with teaching the subject.

DOROTHY M. MELVIN

HEALTH AND DISEASE

PERSONAL HEALTH AND COMMUNITY HYGIENE. *A Revision of Healthful Living for Nurses. McGraw-Hill Series in Nursing.*

By Harold S. Diehl and Ruth E. Boynton. McGraw-Hill Book Co., New York, Toronto, and London. $4.50. xii + 469 pp. 1951.

This is a revised form of the *Textbook of Healthful Living*, published in 1950 by H. S. Diehl. There are some deletions and an occasional rearrangement of the text. There are a few additions, especially introductory pages relative to nursing. Otherwise, the text is unchanged.

HARRIETTE D. VERA

THE SCIENCE OF HEALTH. *Second Edition.*

By Florence L. Meredith. Blakiston Co., Philadelphia and Toronto. $3.75. xiv + 452 pp.; ill. 1951.

According to the Preface, this volume is for use in "hygiene courses where the time allotted . . . is brief but where a comprehensive evaluation of the value of personal and public hygiene is desired." In spite of the proposed purpose of the book, the text is almost entirely devoted to personal hygiene, with a minimum of attention to public health problems. For example, little or no mention is made of such subjects as housing or the cost of and provision for medical care. It seems to me that even in a "short course," the average college student has a right to a broad, thoroughgoing, and scientific approach to the subject.

After an introduction beginning with a chapter on The National Health Situation, Part 2, on the Daily Maintenanc[illegible] Health, makes up nearly half of the book and is c[illegible]erned with matters of personal hygiene discussed in chapters with such titles as Keeping the Circulation Good, Taking in Supplies and Doing Work. Part 3, on Major Health Problems in the United States, deals superficially with communicable and noncommunicable diseases. The fourth part is chiefly a consideration of elementary psychology and its social implications. The final section, entitled The Next Generation, contains information on reproduction, heredity, and parental care.

HARRIETTE D. VERA

C-H-E-C-K. *Community Health Educator's Compendium of Knowledge.*

By Clair E. Turner. C. V. Mosby Co., St. Louis. $3.00. 266 pp. 1951.

Check was written for the purpose of enabling health educators to evaluate their plans and procedures in order to communicate with people effectively. It is a brief rather than a detailed handbook, is mostly in outline form, and at the same time is a sort of guide to appraisal. The text is in three parts: Basic Principles; Working with People; and Media of Group Communication. Sources of printed and visual materials for health education are listed, and there is a bibliography.

The material is well organized, and the presentation is clear and concise. The result is that *Check* should be used with considerable advantage to the educator and to the recipients of that education as well.

HARRIETTE D. VERA

PHYSIOLOGICAL HYGIENE. *3rd Edition.*

By Cleveland Pendleton Hickman. Prentice-Hall, New York. $3.85. xviii + 557 pp.; ill. 1950.

This elementary textbook for college students emphasizes personal hygiene rather than the physiological aspects, although sufficient physiology is incorporated to make a reasonably sound basis for instruction. The first and last four chapters deal with public health matters, and public health problems are also touched upon occasionally in other chapters. The main body of the text presents information on the the various body systems, disease, antibiotics, and principles of immunity. There are a glossary and an index, and appendices containing first aid suggestions and topics for student papers. A few references are given at the end of each chapter.

HARRIETTE D. VERA

COMMUNITY HEALTH EDUCATION IN ACTION.

By Raymond S. Patterson and Beryl J. Roberts. C. V. Mosby Co., St. Louis. $4.50. 346 pp.; ill. 1951.

This book, written in an easy, persuasive style, is a straightforward presentation of the subject. After introductory chapters defining health education and the functions of a health educator, the text discusses present methods of advantageously using various media, including publications, movies, radio, television, and

exhibits. Warnings against poor usage are also given. The final chapter presents methods and practices of appraisal. There are three appendices: Health Education in County Health Departments, by C. B. Smith of Mississippi; Public Health Education in a State Department of Health, by G. W. Larimore of New York State; and A Voluntary Agency's Health Educational Effort, by C. L. Scamman of the Massachusetts division of the American Cancer Society.

HARRIETTE D. VERA

AIDS TO PUBLIC HEALTH. *Sixth Edition.*

By Llywelyn Roberts. Baillière, Tindall, & Cox, London; [Williams & Wilkins Company, Baltimore]. $2.00. viii + 304 pp. 1950.

A diminutive volume packed (in small print) with concise information on public health problems and practices in Great Britain, this book should be valuable for students and professional social and public health workers interested in the British endeavors as compared with our own. The scope of the book is comprehensive, and covers such subjects as vital statistics, housing, sanitation, infectious diseases, and administration. The appendices contain additional information on legislation: (I) National Insurance Act, 1946: Contribution and Benefit Rates; (II) Recent Legislation on Milk; (III) Housing Act, 1949; and (IV) Prevention of Damage by Pests Act, 1949. There are also a list of reference books and an index.

HARRIETTE D. VERA

PATHOLOGY OF THE CELL.

By Gordon Roy Cameron. Charles C Thomas, Springfield, Ill. xvi + 840 pp. + 65 pl.; text ill. 1952.

Few microscopic anatomists have a training in pathology. An even smaller number of pathologists devote their efforts toward problems of normal cytology. Yet both groups are engaged on essentially the same problem, the study of the functional aspects of cells. The abnormal is merely one of these aspects, and for the most part will be understood eventually only in terms of some property or element of normal cells. Yet, in this country at least, few cytologists have more than a nodding acquaintance with pathological specimens, and pathologists frequently have less intimacy with the material and methods used in the study of normal cells. This artificial separation of materials and methods must surely be a great loss for both groups of workers—how great may be seen by a reading of this book.

The text of the book consists of 4 parts: The Normal Cell; The Abnormal Cell; A Critique of the Cell Theory; and Some Aspects of the Study of the Submicroscopic Structure of Protoplasm. The material ranges from protozoa to human among animals, and includes much experimental work on plants. The origins and development of the cell theory are followed by a summary of our present knowledge of the subject. In the same way, a sound historical treatment of pathology in general and of each aspect of abnormality also precedes an account of the current status in each field. This treatment of the subject will be of inestimable value to younger researchers in particular, who all too often are prone to ignore their intellectual heritage. The third part is an excellent critique of great philosophic interest and ends with a clear evaluation of the cell theory as a driving force and of its limitations. The fourth part is a brief account of some of the methods and results of the study of submicroscopic anatomy.

From the foregoing, one would expect a synthesis or at the least an interdigitation of the concepts of the two fields studied. In fact, the relationship is more nearly one of apposition. The developments of normal and abnormal microscopic anatomy are set side by side; so also with the old and the new, the sound and the unsound, the positive and the negative, the microscopic and the submicroscopic.

The book most nearly allied to this one is Wells' *Chemical Pathology*, long since out of print. One seldom finds in Cameron's book the sparkling imaginativeness of Wells, unrestricted by the wealth of detail. As can be seen from the number of references cited (126 pages, about 60 to a page), the present author is reduced all too frequently to the unenviable style achieved commonly in some of our review journals and annuals. There is in addition an author index and a rather incomplete subject index. The printing is attractive and the portraits and other figures well done.

ISIDORE GERSH

PATHOLOGY OF THE FETUS AND THE NEWBORN.

By Edith L. Potter. The Year Book Publishers, Chicago. $19.00. xviii + 574 pp.; ill. 1952.

A new medical classic is established with publication of this book. The subject covers the gamut of pathological conditions likely to be encountered in fetal or neonatal pathology. The treatment is systematic, thorough, and scholarly. The informed reader will find here a broad base for comparison with his own judgments. Edith Potter is recognized as a world authority in the field covered by this book, in view of the prominent work which she has done for more than 2 decades at the Chicago Lying-in Hospital. The scope of this volume reflects her catholic interests in her subject, for it is a veritable compendium of general human pathology. It offers no comparative viewpoint.

A virtue of the volume is 601 illustrations which,

while lacking uniform first-class quality, are nonetheless extensive and sometimes excellent. They make it a museum of fetal pathology. The text is clearly written, in a descriptive style. Consequently, the reader should not look here for an evaluation of underlying causes of the conditions described. The list of references is selective rather than inclusive, and does not touch upon developmental anatomy, physiology, or biochemistry. The index contains about 4000 references, many cross-referenced, so making the volume a ready reference book, especially to Potter's own work and views. This is its greatest virtue.

S. R. M. REYNOLDS

FOOD ALLERGY.

By Herbert J. Rinkel, Theron G. Randolph, and Michael Zeller. Charles C Thomas, Springfield, Ill. $8.50. xvi + 492 pp.; ill. 1951.

Of all the problems in clinical sensitization which face the investigator, that of food allergy is the most difficult to resolve. There are three potent reasons for this: first, the patient lacks objectivity in presenting his problem because of his whims, fancies, and aversions relating to various viands, ideas which are often construed by him as proofs of specific food allergy; second, the physician, shorn in at least half of his cases of the benefit of positive food reactions by skin test, tends to be influenced unduly by the description made by the patient of his untoward behavior with certain comestibles; and third, thanks to the ability of food allergy to mimic many other nonallergic complaints, the actual allergic nature of the particular problem remains debatable and unsettled. Any attempt therefore to introduce a workable, diagnostic procedure for cases of food allergy commands immediate attention.

The authors have presented in their volume their concept of food sensitization and describe the various classifications they employ. Cyclic food sensitization, into which they have divided it, is made up of 3 phases. Each of these phases consists of 3 subdivisions. Phase I consists of masking, omission, and the stage of hyperacute reaction; Phase II, of active sensitization, latent sensitization, and tolerance; Phase III, of tolerance, latent sensitization, and active sensitization.

In their chapter upon Etiology, it is stated that the order of frequency (incidence) of specific food allergens will vary with the individual and with the community in which he lives. Corn, wheat, milk, egg, potato, and orange are listed by them as the allergenic foods of greatest incidence, in the order named. The authors state that sensitivity to corn is the most common cause of food allergy, a declaration which will be challenged in many quarters. Many investigators consider that not only does the order of frequency vary from that described by the authors, but also that the items themselves are different in some instances, egg, milk, seafood, nuts, and seeds being the most frequent offenders in the order named. Not so much importance is attached especially to corn, by many physicians. Such a discrepancy may be at least in part the result of variations in exposure to common foods which occur in different geographical areas, as the authors mention.

In the description of the modes of entry of the exciting food substance into the organism, as by ingestion or inhalation, no emphasis is placed upon the development of allergic symptoms resulting from contact with the unbroken skin. Yet this is a most important clinical problem, seen in food handlers, cooks, kitchen workers, gardeners, when they are in contact with many fresh fruits and vegetables. The importance of this condition as an occupational disease would render interesting and valuable a discussion of the diagnosis and management of such cases.

In detail the authors outline their procedure for their individual food tests, one of which may be made each day for a recommended maximum of 5 consecutive days. The food to be tested is eaten once daily every other day for a minimum of 2 weeks; avoided for 4 days; eaten again on the fifth day. After 5 hours with no food, 4 hours with no medicine, and 3 hours without water or tobacco, the food is eaten and then the following symptoms and data are carefully checked as criteria: sneezing, sniffing, watering of the nose, coughing, wheezing, clearing of the throat, tiredness, headaches, flush of face, pruritus, gastrointestinal symptoms, eczema, pulse readings, leucocyte counts. Obviously the authors' testing procedure is not feasible with infants or with very young patients. Indeed, the management of food allergy in these highly important segments of the population has not been specially discussed. The skin test, scratch and intradermal, has been entirely abandoned by the authors as insufficiently accurate in the diagnosis of food allergy.

There is included a chart containing a Résumé of Common Drugs Useful in the Treatment of Allergy. It would have been most helpful to have discussed at further length, along with recommended drug therapy, the management of allergic emergencies due to foods, with abrupt and severe symptoms of angioedema, urticaria, pruritus, with general nausea, vomiting, diarrhea, gastroenteritis and vertigo, uterine spasm, or asthma, which become the acute concern of anyone involved in the handling of food allergy. There are also included (1) a list of the various food items which have been found to be allergenic, (2) recipes of various types for those who must avoid in their diets, milk, egg, wheat, corn, rye, singly or various combinations; (3) clinical case records of patients with food allergies; and finally, (4) excerpts from the Federal Food Drug and Cosmetic Act.

In this book, a great deal of time and effort has been spent by the authors in an attempt to place upon a workable basis the difficult feat of solving problems in food

allergy. Some of their ideas will meet with acceptance, some will be questioned. The methods of diagnosis they advocate are time-consuming, tedious, and complicated. But so is the condition of food allergy complicated. Anyone in search of a simple and easy diagnostic procedure for this clinical form of sensitization will not find it in this volume nor elsewhere. The subject does not lend itself to an easy solution.

W. C. SPAIN

PATHOLOGICAL HISTOLOGY. *Fourth Edition.*

By Robertson F. Ogilvie; foreword by A. Murray Drennan. The Williams & Wilkins Company, Baltimore. $8.00. xii + 506 pp. + 200 pl. 1951.

The 295 photomicrographs in color which illustrate this volume are its outstanding feature. The criticism that color in a photomicrograph tends to mask the fine linear detail fundamental to an analysis of structure may be overlooked here for two pertinent reasons. First, the material is pathological and is obtained under circumstances where prime fixation, necessary for ultimate delineation of detail, is virtually unobtainable. Second, the color plates are so clearly reproduced that the amount of detail presented is scarcely less than could be expected in good half-tone plates. The color work here is certainly something to be admired and envied.

The present 4th edition has been generally amplified without change in format. The tissue changes of those diseases most commonly encountered in Great Britain are described along with concurrent gross changes. Some etiology is included. An 11-page index ends the book. It is not a reference book, but a volume designed primarily for the histopathologist. Yet the color plates should make it useful to anyone who sometimes has occasion to refer to slides of pathological tissues.

F. N. LOW

POSTURE AND PAIN.

By Henry O. Kendall, Florence P. Kendall, and Dorothy A. Boynton. The Williams & Wilkins Company, Baltimore. $7.00. ix + 204 pp.; ill. 1952.

Accepting the definition of good posture as "that state of muscular and skeletal balance which protects the supporting structures of the body against injury or progressive deformity irrespective of the attitude in which these structures are working or resting," the authors describe the ideal adult posture and those deviations from the ideal that constitute postural faults. This is done by the use of numerous clear illustrations which are explained by concise legends. After considering mobility and the effects on this of muscle length and muscle strength, the authors present a "procedure for a postural examination." There follows a consideration of painful conditions of the skeletal system as seen by the physiotherapist with an evaluation of the role played by faulty skeletal mechanics. The treatment for these conditions is presented under five modalities; heat, massage, stretching movements, strengthening exercises, and supportive measures. In a section on the prevention of postural faults some developmental factors and environmental influences are enumerated.

The writers do not attempt to make this book encyclopedic. They make no attempts to describe the pathological findings or the senescent changes. Instead, they concentrate chiefly on the clinical posture of the young adult and his postural deviations, a field in which their long experience as expert physiotherapists gives them authoritative status. Their concepts are clearly presented in this well compiled book.

I. WM. NACHLAS

ARTHRITIS AND COMMON SENSE.

By Dan Dale Alexander. Bruce Humphries, Boston. $2.50. 182 pp. 1950.

Alexander wrote this book for the person with little or no medical knowledge, offering it as the product of twelve years of "intensive study and observations." The nature of this study is not explained, but it does seem that the author attended a meeting at the International Congress of Rheumatic Diseases and visited the Army and Navy General Hospital at Hot Springs, Arkansas.

The essay is based on the author's theory that "arthritis is a combined fat and steroid hormone deficiency." Alexander claims that his "theories were substantiated time and again under medical supervision," but "the statistical histories are not recorded in this book nor is the medical explanation of [his] theoretical findings." Nevertheless, many attempts are offered to rationalize the dicta expounded. Much of this rationalization is accomplished by loose analogies and generalizations. As an example, the writer supports his belief that carbonated water is harmful by saying, "Take notice of summer epidemics of disease when carbonated water is king." Mr. Alexander feels that "an arthritic . . . does not need a doctor." In all probability the doctor who reads this book will feel that he does not need Mr. Alexander's help in the treatment of arthritis.

I. WM. NACHLAS

THE DIAGNOSIS AND TREATMENT OF ADRENAL INSUFFICIENCY. *Second Edition.*

By George W. Thorn; with the collaboration of Peter H. Forsham and Kendall Emerson, Jr. Charles C Thomas, Springfield, Illinois. $5.50. x + 182 pp.; ill. 1951.

This is an authoritative and explicit manual for clinicians on the differential diagnosis and management of adrenal insufficiency, based on the author's experience with several hundred cases of this relatively rare condition. There is an excellent but very concise introductory chapter on physiological considerations, and throughout the text is abundant illustration of the fact that this disease is primarily a physiological problem. The mortality from recognized adrenal insufficiency was 90 per cent prior to 1930, before specific therapy was available. Now, when highly specific replacement therapy is available, "it is ironical that patients must have their complete rehabilitation jeopardized by financial inability to obtain a well recognized form of therapy." It would seem that some form of group financial responsibility could be the answer to this unscientific difficulty without irreversibly endangering "Western Civilization."

EVELYN HOWARD

INDUSTRIAL MEDICINE ON THE PLUTONIUM PROJECT. *Survey and Collected Papers. National Nuclear Energy Series, Manhattan Project Technical Section: Division IV—Plutonium Project Record, Vol. 20.*

Edited by Robert S. Stone. McGraw-Hill Book Company: New York, Toronto, and London. $6.25. xxiv + 511 pp. + folding chart; ill. 1951.

The National Nuclear Energy Series comprises a record of the scientific contributions and activities accomplished under the Manhattan Project and the Atomic Energy Commission in the utilization of atomic energy for military purposes. Division IV of this Series concerns the Plutonium Project and out of the declassified material pertaining to health under this division, the contents of this Volume 20 are being published in order to cover that portion called Industrial Medicine.

The book comprises both a survey and collected papers. Arthur H. Compton states in a Foreword that, "selecting from this mass of records the most reliable data and presenting them in a useful form has been an enormous task, for which the writers and editors of these volumes deserve the sincere thanks of their scientific colleagues." There are reports on the biological bases for maximum permissible exposures, the hematological effects of ionizing radiations, biochemical studies relating to the effects of radiation and metals, the requirements of an adequate health service in relation to atomic research and industrial development, the blood changes in human beings following total-body irradiation, the treatment of plutonium poisoning by metal displacement, and the tolerance to whole-body irradiation of patients with advanced cancer.

The chapters are each written by different authors and are generally characterized by being well documented and commendably short of speculation. While the book is too highly documented to make it feasible to read for general information, it is a useful reference book to many important subjects in this field. Numerous references are included. Obviously the product of a prodigious amount of scientific work, both experimental and recording, this book fills an important niche in the development of our knowledge on the biological effects of nuclear energy.

FREDERICK W. BARNES, JR.

RECENT ADVANCES IN CHEMOTHERAPY. *Volume II—Malaria. Third Edition.*

By G. M. Findlay. Blakiston Co., Philadelphia. x + 597 pp. 1951.

Volume II of *Recent Advances in Chemotherapy* is a definitive, comprehensive, well indexed, and critical survey of practically all of the recent literature on the chemotherapy of malaria. The author discusses methods of large-scale screening of compounds for antimalarial activity, the various species of parasites and hosts used, as well as the chemistry of the most extensively exploited groups of antimalarial compounds: the cinchona alkaloids, the 4- and 8-aminoquinolines, the acridines, pyrimidines, and biguanides. A separate chapter is given over to pharmacological activity, absorption, tissue distribution, excretion, degradation, and methods for measurement of the most frequently used antimalarials; the toxicity of these same compounds for man is treated separately. Another chapter is devoted to the effect of these drugs on various species of *Plasmodia*, human, simian, and avian, as well as their effects on the various segments of the life cycle of the parasite: sporozoite, gametocyte, endo- and exoerythrocytic parasites. An evaluation is made of the rapidity of action against an overt attack, as well as the effect upon subsequent relapses. A variety of minor groups of compounds is treated separately, including metallic compounds, sulfonamides, naphthoquinones, pantothenic acid analogues, and others. The last two chapters are devoted to the acquisition by the parasite of resistance to various antimalarials and to the mode of action of these compounds.

Findlay's book is the second volume of a series of four which will constitute the 3rd edition of *Recent Advances in Chemotherapy*. The 11 years since the publication of the 2nd edition were the most fruitful years in the history of chemotherapy, and malaria was obviously the most intensively studied disease, chemotherapeutically. The first volume of this edition has 625 pages devoted to scabies, worm infections, and all

protozoan diseases other than malaria; the second volume has 597 pages devoted entirely to malaria. This is rather astonishing, in view of the fact that malaria was one of the first infectious diseases for which a "specific" was found, and again one of the first for which a synthetic organic chemical was of any practical value. Research on malaria during World War II was made necessary partly by a dwindling source of quinine, but more by the realization that the antimalarial agents available were inconvenient for mass therapy and inadequate for the treatment of relapsing malarias. The first two of these practical problems were solved with the discovery of chloroquine and its relatives and of chlorguanide ("Paludrine"), relatively non-toxic compounds which would produce continual suppression if taken in small weekly doses. The problem of the treatment of relapsing malarias had not been adequately solved at the time of the publication of this book. From an academic point of view the mode of action of no antimalarial is known, the mechanism of the acquisition of resistance to drugs is unsolved, and the laws governing the relationship between chemical structure and biological activity remain very sketchy.

This book is a significant contribution to an important field of research, which may unfortunately be abandoned because most of the practical problems seem to have been solved and because of the exactness of the requirements of the malarial parasite.

JOSEPH GREENBERG

AN INDEX OF TUMOR CHEMOTHERAPY. *A Tabulated Compilation of Data from the Literature on Clinical and Experimental Investigations.*

By Helen M. Dyer. Federal Security Agency, Public Health Service, Washington, D. C. Free (paper). i + 329 pp. 1949.

This bibliographic work, indispensable for anyone working in the fields of either chemotherapy or tumors, includes a brief Historical Résumé and a discussion of the Selection of Material for the Index. The Index proper is classified chemically and includes the references to 5031 therapeutic tests of inorganic and organic substances. For each compound tested, information is given regarding the type of tumor, host species and number of individuals, dosage, number of treatments, route, effect claimed, and reference. An Alphabetical Index and a Bibliography of 2213 references complete what is certainly among the most thorough and painstaking pieces of scientific indexing ever carried out. This work provides a model for bibliographic efforts in biological fields.

BENTLEY GLASS

TUMORS OF THE SKIN, *Benign and Malignant. Second Edition.*

By Joseph Jordan Eller and William Douglas Eller. Lea & Febiger, Philadelphia. $15.00. 697 pp. + 3 pl.; text ill. 1951.

The authors are busy practitioners of their speciality, and much of the material for this thoroughly revised and enlarged edition is culled from that experience. This always increases the value and authority of a publication. In addition, however, a great deal of time and effort has obviously been spent on the literature. As a matter of fact, one of the possible criticisms of the book is that such a great number of references has been included. The account of each entity is followed by at least a page of references. There are 23 pages following the section on Carcinomas of the Skin. It seems certain that many of these could have been omitted without loss.

The material is presented in a logical sequence beginning with benign tumors of mesenchymal elements, and followed by a comprehensive chapter on nevi and other developmental disturbances of the skin. Then follows a short chapter on tumors of apparent infectious origin, such as molluscum contagiosum; the very important group of Precancerous Conditions; the frank carcinomas, discussed from a general standpoint as well as according to their anatomic sites; and the malignant melanomas and malignant tumors of mesenchymal elements, including lymphomas. There has been a revision and amplification of this last subject.

Great emphasis has been placed on treatment, surgical and radiologic. Especially has there been amplification of the principles and technique of radiation therapy in all of its clinically applicable forms. There is some question as to the advisability of going into such great detail. While the general principles, uses, and limitations of radiation therapy should be familiar to all those who have anything to do with tumors of the skin, it seems that the actual practice of radiation therapy should be left to the specially qualified radiotherapists. This is a highly specialized field, and even the detailed information given here would not qualify the inexperienced person as a radiotherapist. Irradiation in any form, even that from the popular sun lamp, has potentialities for great harm. It is to be hoped that the information on the subject in this book will be used for general orientation rather than as an inspiration to practice radiation therapy.

Aside from these two points of possible criticism, the book will prove of great value, not only to the dermatologist but to the general practitioner, to the pathologist, and to those in any science who need an orientation with respect to the multitudinous tumors and tumor-like conditions of the skin. Each entity has a succinct textual coverage and, as is necessary in dermatology, there are many illustrations. The clinical pictures will be of particular help, but the photomicro-

graphs are also well chosen and generally of readable reproduction.

J. E. Ash

LES CANCERS PRODUITS PAR DES SUBSTANCES CHIMIQUES ENDOGÈNES. *Actualités Scientifiques et Industrielles, No. 1106. Radiophysiologie Expérimentale Cancer et Hormones, VII.*

By Antoine Lacassagne. Hermann & Cie., Paris. 170 pp. + 3 pl. 1950.

The present volume is a companion piece to the one previously published entitled, *Les Cancers produits par des substances chimiques exogènes*. In the first chapter of the new work, Lacassagne presents the controversial evidence and corresponding claims as to a stimulating effect of cholesterol on neoplastic proliferations and on the transplantability of cancers; as to the quantity and quality as well as distribution of cholesterol in benign and malignant tumors; as to the presence and diagnostic significance of hypercholesterolemia in cancer patients; and as to the rise or fall of the blood cholesterol level in cancer patients after the administration of ionizing radiation. Lacassagne concludes that the concept of an active role of cholesterol in the cancerization process must be abandoned. Cholesterol, however, is not an inert residue in the body but undergoes metabolic changes and participates in the formation of many physiologically active substances, such as the sex hormones.

In the second chapter, after briefly discussing the parasitic-viral theory of Borrell, 1903; the heredity theory of Tyzzer, 1907; the hormonal theory of Lathrop and Loeb, 1916, and Lacassagne, 1932; and the milk factor-virus theory of Bittner, 1936, of mammary carcinomas in mice, Lacassagne summarized the embryonic, postnatal, hormonal, and anatomic aspects of the development of the normal breast and of breast cancers in mice, and the influence exerted by hereditary factors in different strains and sexes on the effectiveness of estrogens in both mice and rats. The possible roles of other endocrine products (pituitary, adrenal), porphyrins, milk stagnation, frequency of gestation, and alimentation are commented upon.

In the third chapter, Lacassagne discusses the observations on extramammary tumors (uterine fibromyomas and endometrial adenomas in mice and rats, uterine fibromas in guinea pigs, uterine cervix carcinomas in mice, testicular interstitial cell tumors in mice, hypophyseal adenomas in rats), on hyperplasias and metaplasias of the hypophysis, bladder, and prostate, on systemic fibromatosis in guinea pigs, on subcutaneous sarcomas at the site of estrogenic hormone injection in mice, and on osteogenic sarcomas and lymphomas, lymphosarcomas, and lymphatic leukemias in mice following repeated administrations of estrogen. The development of analogous neoplastic reactions by several exogenous agents (x-radiation, aromatic amines) is noted.

Tumor production (mammary cancers in mice and rats, bladder papillomas in rats, uterine fibroids in guinea pigs, testicular interstitial cell tumors, lymphosarcomas, leukemias, and pituitary adenomas in mice) by synthetic estrogens (stilbestrol, triphenylethylene) is considered in the fourth chapter. Lacassagne discusses the relative merits of the theories advanced to explain the estrogenic and carcinogenic action of chemically different compounds (identical physiologic action; similar spatial configuration; identical metabolic fragment (diphenyl); metabolic transformation of proesterogens into estrogens), the retention of estrogenic chemicals in different organs, and the anatomic changes produced in them.

The fifth chapter is devoted to a discussion of the possibility of a metabolic transformation of cholesterol and other physiologic steroids into abnormal ones with carcinogenic properties, through bringing about modifications in the side chains of and additions to the fundamental 1:2 cyclopentene phenanthrene nucleus of steroids (estrogen, bile acids); and of the controversial and inconclusive evidence available on this matter from the experimental use of steroid extracts of normal and malignant human and animal tissues, urine, and smegma. The contradictory results of the attempted photochemical transformation in vitro of cholesterol by ultraviolet radiation into a carcinogenic aromatic hydrocarbon are analyzed. The positive cancerigenic effect on the skin of mice by products of the pyrolysis of cholesterol and other cholesterol-containing materials (oil, lard, meat) are contrasted with doubtful ones obtained with them in the stomachs of mice and rats. The fact that bile acids subjected to bacterial fermentation did not change into any known carcinogenic chemicals nor produce tumors when injected, is commented upon.

The last chapter presents a discussion of three theories as to the possible action of estrogens in the cancerization process: estrogens might act as cocarcinogens; they might intervene directly in the cancerization process; or they might assume an indirect role through an intermediary action on the hypophysis. The experimental evidence on hand, according to Lacassagne, lends little support to the first theory. While the second hypothesis cannot be refuted, there is also no proof for its validity. There is some evidence that a hypersecretion of an anterior pituitary hormone is elicited by estrogens and plays a role in the cancerization process. There is finally a short discussion of the therapeutic use of estrogens in cancers of experimental animals, and their application in the treatment of certain human cancers. Lacassagne concludes that the experiences with hormonotherapy in cancer indicate

that autonomy is not an absolute attribute of the cancer cell, as was formerly asserted.

W. C. HUEPER

METHODS IN MEDICAL RESEARCH. *Volume 2. Edited by Julius H. Comroe, Mark H. Adams, and Eleanor H. Venning. The Year Book Publishers, Chicago.* $6.50. xvi + 361 pp.; ill. 1950.

In contrast with biochemistry, where the method is everything, methodology in the physiological and medical sciences is frequently treated as a mere ancillary to far weightier matters; its devotees are labelled technicians, and its efforts spurned by their journals. True, a limit has to be set somewhere. The temptation to modify even one's own most beloved procedures is a dominant one, and the complaint that an author has "failed to repeat one's experiment" is justified in the vast majority of cases, and can often be directed particularly against the plaintiff. Methodology seems to demand a hard core consisting mostly of experience, plus a labile element of improvisation. The former takes time, the latter, imagination. It is perhaps to the first objective that these volumes are principally directed. Competent practitioners unite to present the best of what they have learned as to the modi operandi of their crafts. The present volume includes sections on the Study of Bacterial Viruses, Pulmonary Function Tests, and the Assay of Hormone Secretions. The last section, the only one that the reviewer can appraise from experience, is an excellent introduction to this widely scattered literature, and a constantly useful reference work.

H. R. CATCHPOLE

PSYCHOLOGY AND ANIMAL BEHAVIOR

SEXUAL BEHAVIOR IN PENGUINS. *By L. E. Richdale. University of Kansas Press, Lawrence.* $5.00. xiv + 316 pp. + 16 pl. 1951.

This book contains a wealth of interesting data concerning the behavior of the Yellow-eyed Penguin, *Megadyptes antipodes* (Hombron and Jacquinot), as well as comparisons with similar behavior in many other avian species. The principal categories of behavior are "love habits" and habits of aggression. The author is to be complimented upon the scope of his study, which thus far has involved 973 visits to various colonies and has occupied 10 years of field work. Also praiseworthy is his insistence upon permanently marking individual birds and following their behavior through several successive years. Such methods have revealed the fact that some pairs remain mated for as long as 9 years, whereas other individuals tend to change mates from year to year. Space does not permit the cataloguing of each type of behavior analyzed by the author, but the most significant categories are those of pair-formation, courtship, nest construction and defense, egg incubation, and care of the young.

To me the title of the volume is somewhat misleading. It would have been more accurately entitled "The Social Behavior of Penguins." In the first place, despite his exceedingly numerous observations Richdale never witnessed coition in the species with which he was principally concerned. Secondly, his definition of sexual behavior is so inclusive as to be of dubious validity, or at least of limited usefulness. And thirdly, the data dealing with non-sexual activities are quite valuable and deserve more emphasis than they receive.

The only serious weakness in Richdale's treatment of his subject arises from his tendency to think of penguins as though they were human beings and to interpret the birds' behavior in terms of human motives and emotions. For example, he "explains" certain types of aggregations by saying that the birds are "fond of company"—which is obviously no explanation at all. And elsewhere we find the following statement: "During the incubation and chick stages, fear of the loss of the sex partner does not seem to arise. Anxiety for the safety of the egg or chicks will cause the guardian—of either sex—to threaten or attack . . ." (p. 13).

Perhaps it is ungenerous to complain about such lapses from objectivity, since they spring from precisely those motives which sustained Richdale during a decade of arduous field work. Nevertheless, the discriminating reader will find it necessary to sort out facts from the author's interpretation of them. When this is done, the reward is well worth the effort.

F. A. BEACH

CEREBRAL MECHANISMS IN BEHAVIOR. *The Hixon Symposium. Edited by Lloyd A. Jeffress. John Wiley & Sons, New York; Chapman & Hall, London.* $6.50. xiv + 311 pp. + 2 pl.; text ill. 1951.

This book is the report of a symposium held at the California Institute of Technology in September, 1948, under the auspices of the Hixon Fund Committee. Slightly more than half of the book is taken up by the text of 6 papers presented by the principal participants in the symposium. The rest of the book contains verbatim discussions of the papers by the authors and an additional group of 6 discussants. The titles of the papers and their authors follow: The General and Logical Theory of Automata (John von Neumann, Professor of Mathematics, Institute for Advanced Study); Why the Mind is in the Head (Warren S. McCulloch, Professor of Psychiatry, University of Illinois College of Medicine); The Problem of Serial Order in Behavior

(K. S. Lashley, Research Professor of Neuropsychology, Harvard University); Functional Differences between the Occipital and Temporal Lobes with Special Reference to the Interrelations of Behavior and Extracerebral Mechanisms (Heinrich Klüver, Professor of Experimental Psychology, University of Chicago); Relational Determination in Perception (Wolfgang Köhler, Research Professor of Philosophy and Psychology, Swarthmore College); and Brain and Intelligence (Ward C. Halstead, Professor of Experimental Psychology, University of Chicago). There is a final, summarizing paper entitled The Symposium from the Viewpoint of a Clinician, by Henry W. Brosin, Professor of Psychiatry, University of Pittsburgh, who also acted as chairman of the meetings. The discussants included Ralph W. Gerard, H. S. Liddell, Donald B. Lindsley, R. Lorente de Nó, J. M. Nielsen, and Paul Weiss.

Since this was another "interdisciplinary" symposium, there is little or no cohesiveness among the various contributions except that they all refer to the brain and to behavior. Von Neumann's discussion of automatic computing machinery has practically nothing in common with Köhler's perceptual satiation experiments. But perhaps this is all right. Taken individually, the papers contain many stimulating and original ideas, and there is much of interest in the discussions as well. If you are interested in some facts, ideas, and conjectures about the part the brain plays in behavior, you will find this book rewarding.

A. CHAPANIS

THE COLLECTED PAPERS OF ADOLPH MEYER. *Volume I, Neurology.*

By Adolf Meyer; Eunice Winters, editor. The Johns Hopkins Press, Baltimore. $30.00 (4 vol. set). xxiv + 693 pp.; ill. 1950.

This volume is the first of four which will comprise the scientific writings, in toto, of Adolph Meyer. The contributions extend over the years 1890 to 1945, a remarkably lengthy period of scientific activity. Included are over 250 of Meyer's papers published in many journals, and divided by volume according to subject matter: Volume I, Neurology; Volume II, Psychiatry; Volume III, Medical Teaching; and Volume IV, Mental Hygiene. The greater part of these papers have been previously published, but some of these, privately printed, have not been generally available heretofore. Certain unpublished works are also included.

In each volume the papers have been arranged more or less chronologically and topically. In Volume I, Neurology, the various papers have been grouped into three sections: neuroanatomy, neurology, and neuropathology, each with many subdivisions. The section on neuroanatomy contains a series of papers dealing with comparative neuroanatomy, the segmental-suprasegmental concept, construction of brain models, the optic radiation, the auditory nerves, perspectives, and reviews of various subjects. Certain of these reprints deal with some of Meyer's pioneering findings and concepts, for example, the temporal detour of the optic radiation known as Meyer's loop; and many of the reviews contain his points of view on various controversial topics. It is apparent from the many papers in the section on neuroanatomy that Meyer was interested not only in the rather colorless grouping of centers and tracts as such, but in broader aspects of the nervous system, including the principles of functional development and the relationship of the nervous system to the total personality. Here one begins to see the neuroanatomical perspective which formed the springboard of Meyer's psychiatric interest and research. It can be seen as early as 1898, when he formulated the segmental-suprasegmental concept in the classical paper: "Critical Review of the Data and General Methods and Deductions of Modern Neurology." This formed the basis of his psychobiological theses and the basis as well for his course in the functional anatomy of the nervous system. It was in this course that he made use of the method of reconstruction with plasticene of the nervous system in three dimensions, also adding to these three dimensions the fourth dimension of time by making his reconstructions in such a way that they represented different stages in the development of the nervous system, especially in terms of the segmental and suprasegmental layers as each became unfolded. He continually stressed that as each layer is analysed one must be aware of it in terms of its functions and clinical applications and that the whole system must be constantly interpreted in terms of its relationship to the living organism as a whole. His concept saw the nervous system as a series of ascending levels of integration both structural and functional, a thesis which has been advocated by many, from Henry Head up to the latest book of Himwich, and which certainly has the advantage of being a fairly sound attempt to integrate some of our information about the total nervous system, but which also includes within it certain fundamental disadvantages. However, even though this theory may turn out to be inadequate in the long run, since it is even now running into certain difficulties with our present information, it was most important for it to be developed at the time it was, and it is most certainly not altogether wrong. It has at least for a time provided a new concept for discussion, as well as a rather broad basis upon which to rest those present concepts of psychobiological formulations which are constantly being extended and have become the foundations of psychosomatic problems of today.

The section on neurology deals with such problems as aphasia, syphilis, tumors, trauma, and other problems. The last division of this volume concerned with neuropathology deals with the methods and problems

of central neuritis, as well as certain specialized case reports. It is not difficult to see that Meyer was consistently conscious of the fact that neuroanatomy and neurophysiology must be considered in terms of total psychobiological function; that we cannot go on keeping separate the fields of neuroanatomy, neurophysiology, neurology, and psychiatry, but that all these things must be put together to enable us to study properly the organism in toto or, if one prefers, the individual personality or member of the group. The anatomical correlate is always closely interrelated with the clinical. To Meyer, mind and body were not in separate compartments, but were part of the general biology of the individual and worked together to produce integration of the personality.

This first volume of the notable contributions of Adolph Meyer will certainly be of value to anyone concerned with the problems of the nervous system and their relation to the individual. The papers have been well edited and the book well planned and very beautifully printed and illustrated. If the three volumes to follow are done as carefully, this series should be a most outstanding one, and should become one of the finest source books in its field.

R. G. GRENELL

FACTOR ANALYSIS. *An Introduction and Manual for the Psychologist and Social Scientist.*

By Raymond B. Cattell. Harper & Brothers, New York. $6.00. xiii + 462 pp.; ill. 1952.

Cattell points out in his Introduction that the sources to which the novice may go for an explanation of the theory and techniques of factor analysis are not many. This book is meant to supply that deficiency. It is meant as an introduction to factor analysis for the psychologist, biologist, social scientist, and physical scientist, for whom, Cattell says, factor analysis will prove to be valuable.

The first portion of the book deals with the theory of factor analysis largely from the point of view of Thurstone's centroid method, though other approaches are discussed. Some of the later chapters deal with the O-, P-, and Q-techniques (which Cattell has had a major hand in developing), the special problems of oblique factors, and methods in computation and the design of studies.

At best, the author only partially achieves his aim. I am not very sure that the complete novice would find this book understandable, without considerable guidance. A good deal of statistical sophistication is assumed (by and large, implicitly), and examples are few and far between. Most of the examples come from Cattell's own research and are likely to be a bit esoteric to the outsider. The book would have profited much from the addition of frequent, tailor-made examples of the sort one finds in introductory statistics books.

Despite these difficulties, the careful and persistent reader will be able to achieve a fair understanding of the method of factor analysis with a minimum of mathematics. Since there is considerable enthusiasm among the factor analysts for the application of their method, research workers outside of psychology ought to become more acquainted with it. At this point, however, another criticism of Cattell's book needs to be mentioned. Cattell himself is apparently convinced of the almost universal applicability of factor analysis. This conviction gets enough in his way that he glosses over or does not mention the many inherent difficulties and limitations of the method.

Undoubtedly this book will find use as an elementary textbook in factor analysis, and if the author's enthusiasm is justified, the book will become more important with the passing of the next few years.

JAMES DEESE

ONE LITTLE BOY.

By Dorothy W. Baruch; medical collaboration by Hyman Miller. Julian Press, New York. $3.50. ix + 242 pp. 1952.

This is the case history of Kenneth, a disturbed, asthmatic child, his treatment over a period of years, and the resolution of his difficulties. There is an authenticity to the entire report which would carry conviction even if the author did not assure us that it is a true story. A case history, yet this book is far more than a skeletal outline of a problem situation within a problem family. It is a case history fleshed out with poignant descriptive passages, with clarifying observations on the process of Kenneth's treatment, and with sympathetic evaluations of the dilemmas that involved Kenneth, his mother, and his father.

The story is written with a fine appreciation for the simple, direct use of a child of Kenneth's capacity can make of psychotherapy. Not that Kenneth's problems are simple—far from it—but with Dorothy, as he called his therapist, Kenneth could talk about himself, his feelings, his own body, without any beating around the bush. The security to do so came slowly; but once he was confident of Dorothy, he could talk with her freely and sensitively about his innermost thoughts. His Dorothy has a good ear for recording a child's delicacy of expression and poetry of phrasing, so that throughout the book we feel we are getting acquainted with a real Kenneth and not with some stock character from a psychologist's files. His Dorothy is honest and frank, too, with the material as it unfolds, so that the little boy's sexual confusions, his anal aggressiveness, and his oedipal strivings come out with the greatest clarity.

In a final section the author states why she has written about Kenneth. His basic problems are those with which every child must contend. His environment (and in the course of the story we understand why) prevented a healthy solution for him. Parents can understand dramatically through this one little boy the needs of other children and thus be prepared to fit in more perceptively with the demands of childhood.

HELEN ARTHUR

ADOLESCENCE.

By Marguerite Malm and Olis G. Jamison. McGraw-Hill Book Company: New York, Toronto, and London. $5.00. viii + 512 pp.; ill. 1952.

This is an intelligent well-written textbook on the subject of boys and girls in their teens. The book is divided into 3 sections. Part I, The Adolescent and His World, sets the stage for the rest of the book. It sketches, not pedantically but emotionally, who the adolescent is and what his situation in our society. Part II, The Adolescent and His Adjustment, takes up in a pleasant uncomplicated way the areas of the teen-agers' physical, social, sexual, ethical, and vocational adjustments. The authors, wisely no doubt, stay away from deep dynamic considerations. It is their method to state the facts smoothly and easily, to point out without excess oratory the view they espouse, and then to go on unexcitedly to the next point. Part III, Major Influences on the Adolescent, goes into home environment, community pressure, and school factors. Altogether, this book gives a very complete survey of the adolescent. It should prove to be the kind of textbook that students enjoy.

HELEN ARTHUR

BEHAVIOR PATHOLOGY.

By Norman Cameron and Ann Magaret. Houghton Mifflin Co., Boston. $5.00. xvi + 645 pp. 1951.

In this volume, which may be thought of as a logical successor to Cameron's previous book, *The Psychology of Behavior Disorders* (1947), there is to be found an expression of modern trends of thinking which sees the individual working in a social environment, subject to problems of maturation and growth involved in the management of anxieties, particularly in the early formative years of infancy, childhood, and adolescence. Symptom formation is the end-result of inadequate management of stress and anxiety, and therapy is based upon recall, reconstruction, and working through. This is a thesis to which no one could take exception. The book is organized into chapters dealing with behavior organization, and featuring: (1) need, stress, and frustration; (2) the learning process; (3) symbolization, role-taking, and emotional reactions; and (4) maturation as a general orientative background. There follow special chapters dealing with behavior pathology resulting from (1) biosocial immaturity, either from retardation or social deviation; (2) regression, withdrawal, and invalidism; (3) conflict; (4) anxiety; (5) repression; and (6) the development of what the authors call pseudocommunity, delusion; (7) autistic community and hallucination; (9) disorganization; (9) desocialization; and (10) deterioration. A chapter on therapy is followed by an additional chapter devoted to learning and therapy. As with the preceding volume, the authors have combed the fields of psychiatry and psychology for everything that would seem to be worthwhile in presenting a view of normal and abnormal behavior, and its treatment, from a viewpoint which can be said to be eclectic. In eschewing the traditional formulations of the proponents of the heredity school and the special arguments as to causality advanced by the psychoanalytic school, the authors have succeeded in presenting a very forceful intermediate theory, which will undoubtedly appeal to a large segment of eclectically-minded psychiatrists and and psychologists.

In making this attractive presentation, the authors quite naturally have had to coin some new terms, such as, for instance, "pseudocommunity" and "desocialization," which in the text are easily understood and justifiable, and should not be too great an obstacle to the general acceptance of the book. I find the book, however, somewhat wordy, and have a feeling that it could easily have been condensed into a very much smaller space, by economy of language that would do no damage to their presentation of the subject.

In his previous book, Cameron acknowledged the basic influence of Adolf Meyer in his training. It seems therefore a strange omission that, in the present volume, Meyer's name is not once mentioned in an author index that covers 6 pages of two columns each. As a fellow student under Meyer, I can plainly see his influence in every chapter.

This book is a notable contribution toward the development of a psychology of behavior disorders based on general principles, to which honest men of the most diverse backgrounds can rally.

WENDELL C. MUNCIE

FRONTAL LOBOTOMY AND AFFECTIVE BEHAVIOR. *A Neurophysiological Analysis.*

By John F. Fulton. W. W. Norton & Co., New York. $3.00. i + 160 pp. + 1 pl.; text ill. 1951.

This is another series of the Salmon Memorial Lectures

in Psychiatry. In these lectures, Fulton presents a summary of the work of his own laboratory, as well as of other workers, on the broad problem of frontal lobe functions and the use of brain surgery in the relief of mental disease. The four lectures cover (1) the history of the problem, (2) a summary of functions of the cerebral cortex and certain subcortical systems, (3) a review of behavioral studies of brain-operated animals, and (4) an evaluation of the effects of various frontal lobe operations on human patients.

The first 3 lectures represent a good, up-to-date summary of developments in these intriguing areas of research. One might wish to argue against the concept of the "visceral brain" which Fulton promotes; but certainly one would agree with his basic distinction between the visceral and affective functions of the archipallium and related structures, and the receptive, executive, and associative functions of the neopallium. Certainly, the summary of the behavioral literature shows that lesions of the hippocampus, amygdala, insula, cingulate, temporal tip, and posterior orbital gyrus produce changes in the emotions of animals but not in their learning ability. On the other hand, lesions of the neopallium, in areas 8, 9, 10, 11, 12, and 46 seem more directly concerned with learning capacity and intellectual functions.

The main criticism of this little book is directed against the fourth lecture, in which Fulton tries to summarize what we know about the value of frontal lobe operations in the treatment of mental patients, and in the relief of intractable pain. Without presenting a shred of objective evidence, Fulton concludes that the frontal lobe operation is a "most efficacious therapeutic tool" in "otherwise hopeless psychoses." Unfortunately, most of the studies he cites were done without the benefit of control groups of nonoperated patients, a serious experimental defect, especially since the "spontaneous" rate of cure among untreated patients may be as high as 30% or higher. It does not seem to bother Fulton that the 20,000 patients he says have been operated on since 1935 have taught us very little because they have not been studied scientifically. In fact, without ever once pausing to suggest a good, controlled study, Fulton takes it on himself to recommend what parts of the frontal lobe ought to be taken out in future operations. Let us hope that the next 20,000 patients will not be wasted.

In fairness to Fulton, however, it should be said that he does criticise the early operations on the grounds that they were too crude and needlessly invaded parts of the neopallium which presumably subserve intellectual functions. Also Fulton's intentions are obviously good when he suggests that future operations should be based upon better neuroanatomical and neurophysiological knowledge. But all the neuroanatomy and neurophysiology in the world will not help if the people studying mental patients are unable to say whether or not the brain operation had anything at all to do with the "cure." Only controlled studies of rates of cure among matched groups of operated and non-operated patients will let us evaluate the "therapeutic efficaciousness" of frontal lobotomies.

ELIOT STELLAR

LANGUAGE AND COMMUNICATION.

By George A. Miller. McGraw-Hill Book Company, New York, Toronto, and London. $5.00. xiii + 298 pp.; ill. 1951.

Instead of a science of language, we have had an almost endless variety of splinter sciences studying human sound production and sound reception, semantics, grammar, the logic of signs, the statistics of word or letter usage, and many more of the infinitude of ways of looking at language as a natural phenomenon. Now Miller proposes, at least for purposes of university instruction, to bring these specialists and their parochial interests into focus: to write about language as a part of the behavior sciences, borrowing from the phoneticist and the communications engineer and the auditory theorist and the student of reading, but only what is essential to see language whole.

The book is more nearly successful in such a task than I would have thought possible. To be sure, it is uneven; that was inevitable when the various fields from which data are taken differ so greatly in age and in ease of investigation. Further unevenness may perhaps have been contributed by Miller's own interests. He is at his best when he writes on the perception of speech or on the statistical notions currently known as "information theory." There he writes of topics in which he has been most deeply immersed; there too he writes of facts not previously presented to the undergraduate audience. The section on phonetics is clear and readable. The sections on individual differences and on children's language are certainly adequate. Some of the later chapters, particularly the one called The Social Approach, have the flavor of afterthought, and it may be that the author's heart was not really in them.

It is in the chapters on habit formation and on thinking that psychologists will most often wish to differ with Miller. But a little reflection reveals that phoneticists or engineers or physiologists might quibble over the sections allotted to their specialities, too. It is perhaps too much to expect the author to please everyone. In all fairness, the psychological sections are biassed to the extent that learning theories are oversimplified, and the one Miller chooses is made to seem more elegant and more successful than it really is. Despite that fact, the writing is clear, the solutions or partial solutions to practical problems often ingenious, and the ensemble satisfying as textbook presentation.

It is a pleasure to be able to report that for once a

textbook has been well-written. This book is readable in the best sense. It is never dull or shoddy—even where the factual content is both. The style is adult and is focussed on the subject matter: there is no apparatus of pampering or spoon-feeding or amusing the student. If other authors could capture the spirit of this book, its complete integrity in research and in reporting, both teacher and student would profit.

Language and Communication deserves a wide reading by those beginning their studies in this field. It can also serve as a springboard for those who want to go further. On some topics it is an adequate reference book. Certainly it should inspire many colleges to add courses in language to their curricula.

W. C. H. PRENTICE

PSYCHOLOGICAL WARFARE. *Headline Series, No. 86. By Saul K. Padover and Harold D. Lasswell. Foreign Policy Association, New York.* 35 cents (paper). 62 pp.; ill. March-April 1951.

This little pamphlet gives an historical account of the use of psychological warfare with a few references from ancient literature, but deals more particularly with the George Creel Committee on Public Information in World War I, the development of psychological warfare in the Nazi State, and the development of the principles and methods of psychological warfare in World War II, particularly in our own hands and in the hands of the British. This is followed by a chapter entitled The Strategy of Soviet Propaganda. There are some critical remarks on American psychological warfare, especially as carried on now in the Cold War. These criticisms point to the need for better trained personnel, who will take into greater account the audience's expectation and capacity to believe the truth. It is pointed out that American propaganda, describing truthfully the wealth and relative ease of the common people of this country, is apt to stir up only resentment, if not actual disbelief, in the very countries where propaganda is supposed to generate receptive feelings. The need for humor, satire, even sarcasm, is stressed. Our own problem of racial discrimination is exploited to the full by our enemies, and the fact that we are a capitalist nation ipso facto links us with the capitalist and imperialist exploitations of Asians in years gone by. To ignore these facts is to invite further deterioration of our relationship with the very people with whom we want to be friends. They point up the whole problem as follows: The best radio transmitters in the world and the most far-flung organization of information specialists are no substitute for policy and leadership. ... Apart from a few ... positive statements ... American declarations have been curiously defensive and vacillating, mostly marked by negatives. For instance, we declare ourselves against Russia, against Communism, against dictatorship, without explaining in language which the recipient can understand what this democracy we talk about really means. Our political warfare suffers from intellectual and spiritual emptiness. Perforce it must continue to do so until such a time as the United States shall have formulated a positive program for action, and an ideal around which to rally men. Short of that, we are in danger of talking only to those of our friends who already share our expectations and of losing the great majority of mankind that is still searching for a hope and a vision. Lasswell describes a strategy of Soviet propaganda as having a unity "expressed in the desire to maximize the power at home and abroad of the ruling individuals and groups of Russia." Communist revolutionary strategy occurs in three stages: the first, the formation of small propaganda groups; the second, infiltration through these small groups into labor unions, political parties, and parliament, with the problem of finding allies without losing independence. With allies, the strategy was to keep alive an attitude of suspicion toward the ally, while at the same time lulling him into complacency. The third stage was the coup d'etat.

Lasswell summarizes his chapter as follows: We can sum up Soviet propaganda as a struggle for the mind of man, from the Soviet point of view only, in the sense that it is a struggle for the control of the material means by which the minds of the masses are believed to be molded. Hence the purpose of Soviet propaganda is not peaceful persuasion of the majority of the people in a given country as a prelude to taking power. Rather, the task is conceived as that of a minority, that must remain an ideological minority until it succeeds in accumulating the material means of obtaining a consensus.

WENDELL MUNCIE

HANDBOOK OF APPLIED PSYCHOLOGY. *Two Volumes. Edited by Douglas H. Fryer and Edwin R. Henry. Rinehart & Co., New York and Toronto.* $12.50. Vol. I: xxii + 380 + ix pp.; ill. Vol. II: xii + Pp. 381–842. 1950.

The *Handbook of Applied Psychology* has three aims: (1) to provide a comprehensive survey of applied psychology, (2) to provide a detailed account of specialization in professional work that will show how psychologists apply their principles, techniques, and experimental findings to the solution of everyday practical problems of society, and (3) to provide a description of the organization and administration of professional psychology, its standards and requirements, its relationships with other professions, and its contributions to their practice.

The 2 volumes of the *Handbook* contain 115 contributions prepared by 116 specialists in applied psychol-

ogy and related fields. The contributions are grouped into 18 chapters dealing with various areas of specialization in applied psychology—for example, group living, individual efficiency, personnel psychology, industrial psychology, transportation, educational psychology, penology, and so on.

Because of the enormous amount of material covered and the diversity of the topics included under the heading of applied psychology, the various sections of this work are far from comprehensive reviews. Indeed, most of the contributions tend to be skimpy, serving only to introduce the reader to the problems and some of the principles in specific areas. Nonetheless, this is by far the most comprehensive survey of applied psychology on the market and it should be a valuable reference source for psychologists and others interested in the practical applications of scientific psychology.

A. CHAPANIS

MAN INTO WOLF. *An Anthropological Interpretation of Sadism, Masochism, and Lycanthropy. A Lecture Delivered at a Meeting of the Royal Society of Medicine. By Robert Eisler; with an introduction by Sir David K. Henderson. Philosophical Library, New York.* $6.00. 286 pp. 1952.

Here is a rather strange book in all respects of theme, composition, intention, and even physical format. In essence it is a brief lecture, presented by the late Dr. Eisler—one of the most ambitious and scholarly anthropologists of modern times—before the Psychiatric Section of the Royal Society of Medicine. Although the content of the lecture is limited to "an anthropological interpretation of sadism, masochism and lycanthropy," it was the author's ambition that his findings and remarks would apply more widely, indeed, universally.

Toward the conclusion of his lecture, Eisler stated the purpose toward which his inquiry was conducted. This study, he conceived, might be "the starting point for a new approach to the greatest and most topical problem . . . of all history: must wars, 'human nature being what it is,' go on . . . or is there a hope of peace on earth . . .?" And his answer, based upon anthropological researches utilizing a Jungian approach is that ". . . if it were true that all our ancestors have been carnivorous, or even omnivorous, predatory beasts, I would resignedly admit that, 'human nature being what it is,' wars must inevitably go on to that bitter end which may be as near as many of us fear. If there was never a Fall, there can never have been and there can never be a redemption in the future. If, however, there was a most definite Fall, if 'human nature' was originally not lupine but that of a peaceful, frugivorous, non-fighting and not even jealous animal [which Eisler's data seem to show—R. L.], which developed its present predatory, murderous and jealous habits only under extreme environmental pressure by extra-specific imitation of the blood-lustful enemies of its own species, then there is hope of changing our social organization and our environment, gradually or suddenly, in such a way that we can throw off the fatal wolf's mask, tame the 'archetypal' beast in ourselves, and restore mankind to its pristine state of *ahimsa* or in-nocence, so achieving peace. . . ."

It is, in my opinion, a great pity that the author and his publishers saw fit to present this lecture in the form of the present book. The presentation, running to about 30 pages of text preceded by a gratuitous Introduction by Sir David K. Henderson and an Author's Foreword, and followed by more than 200 pages of Notes, is completely buried. A reader can only be impatient with a book format that deprives him of information if he chooses to read the Lecture and save the Notes for later, or makes him imitate a windmill if he tries the even more uncomfortable choice of reading a phrase, then its attached Note at the back of the book, then to resume reading further. Surely Eisler and his ideas deserved better than this.

ROBERT LINDNER

THE YEARBOOK OF PSYCHOANALYSIS. *Vol. 7, 1951. Managing Editor, Sandor Lorand. International Universities Press, New York.* $7.50. 271 pp. 1952.

The current volume maintains the high standards set by the preceding issues of the series. The 22 papers included here are stimulating, cover a wide range of topics, and are contributed by outstanding members of the psychoanalytic profession. With 2 exceptions, all the papers have been published previously, either in *The Psychoanalytic Quarterly* or *The International Journal of Psychoanalysis*. From these two sources the editors have done a splendid job of selecting key articles and bringing them together in an intelligent and effective combination.

HELEN ARTHUR

THE UNIVERSAL DESIGN OF THE OEDIPUS COMPLEX. *The Solution of the Riddle of the Theban Sphinx in Terms of a Universal Gestalt. By Francis J. Mott. David McKay Co., Philadelphia [distributor, Robert Brunner, 1212 Avenue of the Americas, New York 19].* $7.50. xvi + 292 pp. + 2 pl.; text ill. 1950.

This volume completes for the moment the author's trilogy, in which he has described his "new psychological venture called biosynthesis." Biosynthesis, we are told, is a systematic psychology which is rooted in the nature of the world and of society, and in the whole

nature of man. Man and universe are linked in the central experience of their origin: The universe began its existence as a nuclear time-point which "exploded" and became hollow. Every man begins life as a compact of nuclear feeling in the womb, and at birth is "exploded" and made hollow. The drama of King Oedipus is perceived to be the drama of every man alive, as it is also the drama of the entire universe.

Now, Oedipus slew his father and married his mother; for Freud this appeared to exhaust the possibilities of the myth. He had no intimations that the story of Oedipus is the social projection of the "repressed" memories of uterine and umbilical feelings. A fresh insight into the nature of the Oedipus complex has been made possible by the author's new technique, namely, a new method of dream analysis linked with the concept of a Universal Design, or Universal Gestalt or Pattern. Freud never lifted the dream to the level at which it could become an instrument for scientific investigation of the unconscious. It has remained for biosynthesis to achieve this system. The new "organon" of dream research is partly a matter of maintaining a delicate interplay between the symbolism of individual dreams and the symbolism of mythology. A myth is simply a "big dream," which is to say a unification and syncretization of a number of individual dreams, called "little dreams." The story of King Oedipus is a "big dream" that tells us in outline the story of the relation of the fetus to the womb, of the umbilical affect, of the sufferings of birth and of the transformations of the affect in the postnatal body.

Now, the Riddle of the Sphinx: "What is the being with four feet that has two feet and three feet and only one voice; but its feet vary and when it has most it is weakest." Well, this being is man, crawling on all fours as an infant, walking on two feet throughout most of his life, and needing a staff as a third foot when he is bent with age. It will be evident, says the author, that there is some meaning here which is not visible upon the surface, for the best brains of Thebes could hardly have failed to perceive the answer to this transparent enigma. (However, the Sphinx was evidently satisfied with this surface-solution and expired instantly as it had promised to do.) The author argues that we may straightway understand that the riddle should concern the feet, for Oedipus himself is the man with the Swollen Feet. Since we see that the swollen feet are really substitutes for the lost placenta, to which the umbilical legs carry the blood, we suspect that the riddle concerns the developing relations of the human organism to its placental and umbilical feelings. This interpretation of the riddle fits it neatly into the picture which our Big Dream is yielding in the light of biosynthesis. It is obvious that whoever wants to know more about Biosynthesis—"the natural, hence the only possible, line of evolution of Freudian psychology"—must study the author's trilogy; and whoever desires to understand his interpretation of an old mythos by a new myth must read this present volume. It will be an adventure, and the reader is advised to heed the motto with which the book opens. It is a quotation from Chapter 20 of the Gospel of St. John. It ends with the words, "and be not faithless, but believing."

WALTER O. JAHRREISS

PSYCHOANALYSIS—*Evolution and Development. A Review of Theory and Therapy.*

By Clara Thompson, with the collaboration of Patrick Mullahy. Hermitage House, New York. $3.00. xii + 252 pp. 1950.

The author has rendered invaluable and yeoman service to the student of psychoanalysis, the psychoanalytic profession, and as well to the intelligent layman, in gathering together seemingly divergent threads that have led to the present status of psychoanalytic theory and therapy. Her effort emerges as a lucid, not too technical, comparative exposition, of particular value to the student of psychoanalysis who finds himself confused by the multifarious claims and counterclaims of the various schools of psychoanalysis, each of which purveys its theory and practice in the marketplace of ideas as the authoritative, final word in the field. This study, by tracing the development of each leading movement, its acceptance or rejection, its validation or non-validation (partial or total) in therapy, and its influence or obsolescence in the field of pschoanalysis today, should lay to rest the combative, competitive striving for "position" of each school; and should instead serve as the foundation for further experimentation and theoretical development based on a common denominator.

For there exists such a common denominator. This common denominator is the agreement amongst the overwhelming majority of psychoanalysts in America today that the influence of environment upon the individual (interchangeably called the cultural or interpersonal) approach is the field of examination, which in the past four decades, has resulted in the most fruitful theoretical and therapeutic gains. Without attempting to detract from the basic and monumental achievements of Sigmund Freud, his "instinctual" or "hereditary" approach, as Clara Thompson demonstrates, had lead to an impasse in therapy and theory. Today his most ardent devotees point up Freud's "cultural" insights. However, Clara Thompson, granting that insight into cultural factors, nonetheless quarrels with this "cultural" approach, and points out its subordination to Freud's basic "instinctual theories," asserts his lack of knowledge of comparative cultures, cites his defense of existing irrational cultural factors, and his belief that cure was the patient's adjustment to these factors (in his opinion, immutable, enduring, and unchangeable).

Since the author considers that Patrick Mullahy's book, *Oedipus Myth and Complex*, has already brought "together in one book the main theories of all the different schools of psychoanalysis," she considers it unnecessary to repeat all the data in her present study; but considers her study instead a critical companion piece based on Mullahy's data. Nonetheless, her explanation of the various contributing schools of thought is adequate and clarifying. Thus the contributions of Adler, Jung, Rank, Ferenczi, Reich, Horney, Sullivan, and Fromm are sufficiently detailed to carry forward her thesis that this "infant science . . . has a forward moving direction to which all of the different schools have contributed." The operation of the common denominator referred to above can be illustrated concretely in her treatment, for example, of anxiety. From Freud's first thesis that "anxiety is purely a physiological reaction," she traces his second formulation that "neurotic behavior is developed in an attempt to cope with anxiety." With this second formulation, present-day psychiatric thinking agrees. However, on this Freudian foundation, the "inner impulses which threaten security are now seen to be largely *forces created by cultural pressures*." Thus the functional operation of anxiety is a thread leading from Freud to Sullivan and Fromm, even though Freud postulates anxiety as an instinctual reaction, and Sullivan and Fromm as a loss of euphoria created by cultural pressures.

These pressures, in Clara Thompson's view, are so important that she postulates the aim of psychoanalysis as seeking to "free him [the patient] from its [society's] irrational demands and make him able to develop his potentialities and to assume leadership in building a more constructive society." She laments, however, that "even today, it is a relatively small group of analysts who are interested in developing a science of human relations based on a study of cultures." Her book should help stimulate interest in this direction.

WENDELL MUNCIE

INTRODUCTION TO A PSYCHOANALYTIC PSYCHIATRY. *2nd Printing.*

By Paul Schilder; authorized translation by Bernard Glueck. International Universities Press, New York. $3.25. x + 178 pp. 1951.

This second printing of Schilder's book, which first appeared in English in 1927, is just as intriguing and provocative as it was then. His comments on the problems of psychiatry, arising from his own observations and his knowledge of the literature, are just as stimulating today as then. It may be added that we are not much further along in understanding them. Schilder had a unique quality of synthesizing data from the most diverse fields into hypotheses and questions with unusual interest and significance. There was no one quite like him then, and no one has followed adequately in the direction he pointed out.

Aside from the arguable material on the basic psychoanalytic theories of personality organization, the most enjoyable chapters are concerned with the dynamic aspects of schizophrenia, and the toxic and organic psychoses. When anyone can say, as he did, that general paresis could be analyzed for therapeutic purposes, one should sit up and take notice. On the other hand, he quickly qualified that assertion with a sage observation that physical treatment seemed so promising that therapeutic psychoanalysis should not be substituted. This book should be read by any student of psychiatry who finds himself becoming accustomed to routine ways of looking at his material. He will get some helpful jolts.

WENDELL MUNCIE

THE PSYCHOANALYTIC STUDY OF THE CHILD. *Volume VI.*

Edited by Ruth S. Eissler et al. International Universities Press, New York. $7.50. 398 pp.; ill. 1951.

Like the preceding volumes of this series, this one too is an excellent collection of very useful clinical and theoretical papers within the field of child psychoanalysis. The papers, 22 in all, are organized under five headings: Problems of Child Development; Problems of Masturbation; Early Childhood; Latency; and Adolescence. The section on Latency, as an example, includes 5 papers. The first article, by Berta Bornstein, was given originally at The American Psychoanalytic Association's annual meeting in 1951. It is an exceedingly stimulating presentation of the dynamic processes that are operating in the years from 5 to 10. The author divides latency into early and late phases, emphasizing that the first few years are occupied with the individual's separation from his infantile position and the later years, age 8 to 10, are involved with the establishment of ego defenses. This concept, of course, is highly important in considering the goals and techniques for therapy in the latency period.

Selma Fraiberg has 2 excellent papers in the same section. In one, Clinical Notes on the Nature of Transference in Child Analysis, she shows how children do have transference reactions within psychoanalytic therapy. She discusses how this transference comes about and what the factors are which make it a limited phenomenon. In her second paper, Enlightenment and Confusion, Mrs. Fraiberg makes a very good point about sex education, namely, that many children, although given the facts, utilize this information to substantiate their infantile misconceptions rather

than to clear them up. The result, of course, is compounded confusion.

This is a brief sampling of the type of paper represented in the volume. It is a book to be included, by all means, in the practicing psychoanalyst's library. For the student of child psychology who is oriented in psychoanalysis, it has much to offer.

HELEN ARTHUR

JOURNAL OF THE HILLSIDE HOSPITAL. *Vol. I, No. 1. January, 1952.*

Edited by Sidney Tarachow; Joseph S. A. Miller, associate editor. Published for the Hillside Hospital, Glen Oaks, N. Y. by The Society of the Hillside Hospital; distributed by International Universities Press, New York. Annual Subscription, $3.00, single issues, $1.00. Vol. I, No. 1, 62 pp. 1952. (Editorial address, Sidney Tarachow, M. D., Editor, Journal of the Hillside Hospital, 12 East 86 Street, New York 28, N. Y.)

The chief purpose of this new journal is to "serve as an educational medium in psychiatry and its related disciplines. . . ." Several regular departments will include original papers; reports of clinical case conferences at the Hospital; current Hospital activities. Contributions of original papers are open to any qualified workers in the field. The contents of the first issue are as follows: A Contribution to a Symposium on Religious Art and Literature (Fritz Wittels); World Destruction Fantasies in Early Schizophrenia: a Rorschach Study (Milton S. Gurvitz); Tactile Perceptual Tests in the Differential Diagnosis of Psychiatric Disorders (Morris B. Bender and Max Fink); The Role of the Social Service Department at Hillside Hospital (Abraham Lurie); Clinical Conference; Hospital News and Notes.

HUMAN BIOLOGY

ASIA'S LANDS AND PEOPLES. *2nd Edition.*

By George B. Cressey. McGraw-Hill Book Co., New York, Toronto, and London. $7.00 (textbook edition). x + 597 pp.; ill. 1951.

This comprehensive and sympathetic study of Asia and the national problems of its peoples has been considerably revised since its first edition, which appeared in 1944 (*Q.R.B.* 19: 357). Prominent changes include post-war production figures; separate chapters or rewritten material on Korea, Pakistan, Israel, and Indonesia; nearly 100 new photographs; and redrawn maps showing new boundaries and other pertinent material. The author points out that nationalism has brought independence to half a billion people since the Second World War, but problems of livelihood remain largely unsolved. "The Soviet Union transformed its economic life in the period between the First and Second World Wars, and China may well duplicate this development during the second half of the twentieth century." The book presents, in an attractive manner, a vast amount of well illustrated, factual material essential to an understanding of the present world dilemma.

EVELYN HOWARD

GEOGRAPHY OF RUSSIA.

By N. T. Mirov. John Wiley & Sons, New York; Chapman & Hall, London. $6.50. xii + 362 pp.; ill. 1951.

A non-analytical account of Russian terrains. 40 introductory pages describe location, climate, geology, topography, rivers, lakes. 25 pages are devoted to historical geography, peoples, languages, religions. The rest of the text is a description of 20 geographical regions of the country. There are no pictorial or diagrammatic illustrations. There is practically no bibliography, except 13 references to Chapter 28, Islands in the Arctic, and no satisfactory geographic maps, except 34 most highly generalized black-and-white map outlines in the text. A superficial and naive treatment of the subject and an odd choice of occasional references (e. g., on p. 78 a Naval Intelligence Handbook is cited as the authority on the Orthodox Church), a lack of interest in the geographical processes, in the natural and cultural evolution of terrains, and a reluctance to attempt either analysis and generalization, together with the absence of illustrations, are only partially redeemed by an apparent reliability of some data (weight of some mountains, names of animals, plants, etc.). The book may be useful, in some courses, but only as a supplement to others. Its relative success is an indication of a demand outstripping the supply of good textbooks on the subject. One is tempted to quote a Russian proverb, "na bezryb'i i rak ryba"—"in the absence of fish a crayfish is fish."

V. P. SOKOLOFF

THE AMERICAN INDIAN. *An Introduction to the Anthropology of the New World. Third Edition, Reprinted.*

By Clark Wissler. Peter Smith, New York. $5.50. xviii + 466 pp.; 9 pl. + folded map; text ill. 1950.

This is a reprint of the Third Edition, which was published in 1938 (Q.R.B., 13: 354. 1938). It is indeed well that this classic of Indian anthropology is not allowed to go out of print.

THE CALIFORNIA INDIANS. *A Source Book. Compiled and Edited by R. F. Heizer and M. A. Whipple. University of California Press, Berkeley and Los Angeles.* $6.50. xiv + 487 pp. + 2 pl.; text ill. 1951.

One indication that a science has reached maturity is the disappearance of the sources from the market and the appearance of source-books for use in large lecture classes for which available library resources are restricted or non-existent. Kroeber's famous *Handbook of the Indians of California*, (Smithsonian Institution, 1925) known to anthropologists as "Bulletin 78 of the BAE", and among booksellers as a "twenty-dollar item," has long since been beyond the reach of students. But Kroeber and his students have gone on cultivating the area and publishing widely until the present source book is both possible and meets a felt need. It covers general surveys such as population, archeology (Beardsley's "Cultural Sequence"), historical accounts (the Colorado Yumans in 1775 by Pedro Font), ethnology: material culture (basketry, by O'Neale), social culture (Yurok law and custom), Ishi, the last Yahi—"perhaps the most remarkable personality of his century" (T. T. Waterman). Teachers of anthropology will welcome this book and no student can afford to be without Heizer and Whipple, replete with illustrations and maps.

WILLIAM N. FENTON

EXCAVATIONS ON UPPER MATECUMBE KEY, FLORIDA. EXCAVATIONS IN SOUTHEAST FLORIDA. *Yale Univ. Pub. Anthrop., Nos. Forty-One and Forty-Two.*

(41) By John M. Goggin and Frank H. Sommer III; (42) By Gordon R. Willey. Yale University Press, New Haven; Geoffrey Cumberlege, Oxford University Press, London. $3.50 (paper). (41) 104 pp. + 8 pl.; text ill.; (42) 138 pp. + 16 pl.; text ill. 1949.

ARCHEOLOGY OF THE FLORIDA GULF COAST. *Smithsonian misc. Coll., Vol. 113 (whole volume). Pub. 3988. By Gordon R. Willey. Smithsonian Institution, Washington.* $4.00 (paper). xxiv + 600 pp. + 60 pl., 2 maps, 2 charts; text ill. 1949.

BIOMETRY

A PHILOSOPHICAL ESSAY ON PROBABILITIES. *By Pierre Simon, Marquis de Laplace; translated from the Sixth French Edition by Frederick Wilson Truscott and Frederick Lincoln Emory; with an introductory note by E. T. Bell. Dover Publications, New York.* $1.25 (paper). viii + 196 pp. 1951.

Biologists ought indeed to be grateful to Dover Publications for their undertaking to reprint in relatively inexpensive editions the great scientific classics. This one, although strictly speaking it is in the field of mathematics, possesses great interest for all who work with probabilities. The *Philosophical Essay on Probabilities* formed the general introduction (first published in 1819–20) to the great mathematical work of Laplace, the *Théorie Analytique des Probabilités*. It is itself easy and fascinating reading, much of it a transposition into common language of certain mathematical parts of the *Théorie Analytique* dealing with the applications of the calculus of probabilities to games of chance, the indefinite multiplication of events, to natural philosophy, the moral sciences, testimonies, the selections and decisions of assemblies, the judgments of tribunals, tables of mortality, and the like.

BENTLEY GLASS

THE PLACE OF STATISTICAL METHODS IN BIOLOGICAL AND CHEMICAL EXPERIMENTATION. *Ann. N. Y. Acad. Sci., Vol. 52, Art. 6. Pp. 789–942. By Edwin J. de Beer (ed.), and 15 contributors.* $2.25. (paper) 1950.

This symposium includes papers certain to be widely useful to all biologists who use statistical methods, as who does not. It will be specially valuable to those concerned with biological assays. Contents: Introduction (E. J. de Beer); The Statistical Part of the Scientific Method (George W. Snedecor); The Function of Designs in Experiments (Gertrude M. Cox); Some Rapid Approximate Statistical Procedures (Frank Wilcoxon); Statistics in Analytical Chemistry (W. J. Youden); A Plant-Scale Planned Experiment in Penicillin Production (K. A. Brownlee); Statistics in Nutrition Research (Robert A. Harte); Some Examples of the Use of Statistics in Pharmacology (C. V. Winder); Statistics in Experimental Immunology (H. C. Batson); The Design of Biological Assays (C. I. Bliss); Statistics in Microbiological Assay (Lila F. Knudsen); Biological Assays Involving Quantal Responses (Lloyd C. Miller); Statistics in Biological Assay: An Example of the Graded Response (Bert. J. Vos); Statistics in Clinical Research: Some General Principles (Donald Mainland); Statistics in Clinical Research (D. D. Reid); What is a Mortality Rate? (H. M. C. Luykx).

ADVANCED STATISTICAL METHODS IN BIOMETRIC RESEARCH. *By C. Radhakrishna Rao. John Wiley & Sons, New York; Chapman & Hall, London.* $7.50. xvii + 390 pp. 1952.

The interesting and valuable contribution of this book lies in the excellent treatment of recent statistical developments in the field of multivariate analysis. These new techniques have great potential value in the biological and social sciences (the examples in the book deal with anthropometric studies and psychiatry).

Rao presents these methods in a workable form with numerous detailed examples. Clear, common-sense explanations accompany the examples. Much of the material is not in the literature or is inaccessible in the literature.

The discussion of classification, discrimination, and group structure comprises the last 3 chapters of the book, and this presentation is more than enough to warrant a place for this book in any biometric library. The first 6 chapters suffer by comparison with the last 3. They are good but not noteworthy.

Nearly half of the book (the first 4 chapters except for 3f) is devoted to a summary of mathematical statistics. This is customary, but it is hoped that future books on advanced statistics will abandon this useless custom. One cannot *learn* the material from such a compact presentation, and various other books could provide the necessary *review*. What is worse, the author in an effort to be brief is forced to make misleading categorical statements. The treatment of the analysis of variance (see the discussion of interaction on p. 94) is a case in point. The treatment of estimation also suffers. Much of the material dose not belong in this book. Certainly this chapter fails to provide "a complete answer to critics who hold that the method of maximum likelihood leads to intractable equations."

One nice feature of this book is that it brings in the work of Indian statisticians (such as Dandekar), and thus keeps Americans informed about work that is going on in India.

I. Bross

DE OMNIBUS REBUS ET QUIBUSDAM ALIIS

Proceedings of the London Conference on Optical Instruments *Held at the Imperial College, London, S. W., July 19–26, 1950.*

John Wiley & Sons, New York. $7.00. xvi + 264 pp. + 12 pl.; text ill. 1952.

Biologists will find considerable material of interest to them in this volume. The papers are mainly at the engineering, rather than the theoretical level, and reflect a very active development of optical equipment that could be of service to research workers. The main categories of papers are as follows: photographic and projection lenses; reflecting microscopes; phase contrast microscopes; spectrophotometers; reflecting telescopes; new optical materials.

L. J. Mullins

Practical Spectroscopy. *Prentice-Hall Physics Series.*

By George R. Harrison, Richard C. Lord, and John R. Loofbourow. Prentice-Hall, New York. $6.65. xvi + 605 pp.; ill. 1948.

Because of the importance for biological work of spectroscopic methods, it is gratifying to see the appearance of a volume such as this, the result of a collaboration between workers in the physical and the biological sciences. Although mainly a book on methods, a generous amount of theoretical introduction to the various chapters is given in each instance. The methods detailed, together with an analysis of limitations and errors are: emission spectrographic analysis, absorption spectrophotometry in the ultraviolet, visible, and infrared regions, spectroscopy in the vacuum ultraviolet, high resolution devices for spectroscopy, and a general discussion of optical principles involved in both grating and prism instruments.

L. J. Mullins

Science News 23.

Edited by A. W. Haslett. Penguin Books, Harmondsworth-Middlesex, and Baltimore. 50 cents (paper). 142 pp. + 16 pl.; text ill. 1952.

Contents of a biological nature: Cortisone—a Problem in Chemical Synthesis (A. J. Birch); Vitamin B_{12} Antibiotics and Growth (H. O. J. Collier); The Problems of Bird Orientation (G. V. T. Matthews); Central Cerebral Processes (G. M. Wyburn); Millipedes in Agriculture (J. L. Cloudsley-Thompson); West African Experiment; Research Report—(1) Patterns of Smell, (2) Plant Viruses (A. W. Haslett).

Science News 24.

Edited by A. W. Haslett. Penguin Books, Harmondsworth-Middlesex, and Baltimore. 50 cents (paper). 128 pp. + 16 pl.; text ill. 1952.

Biological contents: The Measurement of Mental Images (P. L. Short); The Chemistry of Cells and Chromosomes (D. L. Woodhouse & H. S. A. Sherratt); Taking a Sample (J. A. Nelder); Research Report—Selenium in Plants (A. W. Haslett).

Science News 25.

Edited by A. W. Haslett. Penguin Books, Harmondsworth-Middlesex, and Baltimore. 50 cents (paper). 128 pp. + 16 pl.; text ill. 1952.

Articles of biological interest: Concepts out of Context: the Pied Pipers of Science (N. W. Pirie); Dietary Self-Selection Experiments (D. E. Tribe); The Mechanism of Mineral Salts Absorption by Plants (J. F. Sutcliffe); Colour Vision (Katherine Tansley & R. A. Weale); Consciousness and the Brain (Margaret Knight); Research Report—(1) Electric Fishes, (2) Sources of Animal Carbon, (3) Anti-Vitamin Rat Poison, (4) Raw Material for Cortisone.

COLOR IN BUSINESS, SCIENCE, AND INDUSTRY.

By Deane B. Judd. John Wiley & Sons, New York; Chapman & Hall, London. $6.50. ix + 401 pp. + 2 pl.; text ill. 1952.

Judd needs no introduction to visual scientists. Associated with the National Bureau of Standards for over 20 years, he has been Chief of the Colorimetric Unit since 1946. His many publications in the field of color vision and colorimetry have earned him the reputation of being one of the world's foremost authorities on the subject. It would be difficult to think of anyone better qualified to write a book such as this.

The purpose of the book is best stated in the author's own words: "It has been my privilege, in my twenty years at the National Bureau of Standards, to come into contact with hundreds of colorimetric sore spots in our industrial life. I have seen victories that paid off in dollars and cents won by applying the sciences of mathematics, physics, and psychology to these problems. In particular, a whole new science has been developed, largely since the turn of the century, applying to many of these color problems. This is the science of visual psychophysics. The key to color problems of the future is to be found in visual psychophysics mixed with a liberal sprinkling of common sense. This book is an attempt to present visual psychophysics in terms that are practically useful."

The text is divided into 3 major sections. Part I, Basic Facts, discusses the eye, basic concepts in color, color matching, and color vision defects. Part II, Tools and Technics, the largest section of the three, contains thorough discussions of spectrophotometry, colorimetry and colorimeters, the reproduction of color in pictures, color standards, color scales, and color terms. Part III, Physics and Psychophysics of Colorant Layers, considers gloss, opacity, and colorants generally. The appendix contains several basic tables of use in colorimetry and an extensive bibliography.

This is a basic reference work which should be in the library of all those who are concerned with the science of color in any of its aspects.

A. CHAPANIS

TODAY'S SCIENCE AND YOU.

By Lynn Poole; illustrated by Jeanne Bendick. Whittlesey House, McGraw-Hill Book Company: New York, London, Toronto. $2.75. 208 pp.; ill. 1952.

This is strictly popular science writing, well done in spite of some inaccuracies; e.g., diagrams of atoms show no inner shell; radiocarbon dating sounds much too exact. The book should have a wide popular appeal.

ELLA THEA SMITH

HARWELL. *The British Atomic Energy Research Establishment, 1946–1951.*

By British Atomic Energy Research Establishment, Harwell. Philosophical Library, New York. $3.75. 128 pp. + 20 pls.; text ill. 1952.

This is an interesting and detailed account of the activities at Harwell. There is no research program there in biology or medicine, as this work is considered to be more easily carried out in universities. Studies in progress are related to isotope production, reactor operation, accelerator operation, and nuclear fuel production.

THE QUARTERLY REVIEW OF BIOLOGY publishes critical reviews of recent researches in all of the special fields of biological science. The contribution should present a synthesis or digest of the researches and a critical evaluation of them. A mere synopsis of the literature without evaluation or synthesis is not desirable.

Theoretical papers are published occasionally, especially when such papers (1) include a critical synthesis of the literature bearing on the theory and (2) are likely to promote further research in a given field.

The article should be written in concise language, yet in sufficiently non-technical form as to be intelligible not only to specialists in other fields but to the general biologist as well. To this end the article should have a general introduction and a summary which enumerates one by one all of the principal facts and conclusions given in the paper. Interpretative diagrams and schemes are very desirable.

Material ordinarily taking the form of footnotes is set in small print and placed in the text and consequently should be written in a style so as to fit readily into the text. Acknowledgments are printed in the text in small type at the end of the article just preceding the List of Literature. Recent issues of the Quarterly should be examined for style as regards (1) section or subsection headings in the text, (2) literature citations in the text, and (3) List of Literature.

The subjects and authors of articles are selected by the Editors and members of the Advisory Board. Unsolicited articles which conform with the objectives of the Quarterly will be considered for publication.

A feature of the REVIEW is the section dealing with *New Biological Books*. In this department the book literature of different countries in the field of Biology is given prompt notice.

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